A COMPUTER SIMULATION FOR THE EVALUATION OF FLEET AIR DEFENSE EMPLOYING MONOSTATIC AND BISTATIC SEARCH RADARS

Richard John Leonhardt

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

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by

Richard John Leonhardt
and
Charles Robert Schlegelmilch

March 1975

Thesis Advisor: A. F. Andrus

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by

Richard John Leonhardt
Lieutenant Commander, United States Navy
B.S., University of Notre Dame, 1965

and

Charles Robert Schlegelmilch
Lieutenant Commander, United States Navy
B.S., Marquette University, 1961

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requirements for the degree of

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I. INTRODUCTION

The purpose of this thesis is to develop a computer simulation model for use in analysing the Navy's Fleet Air Defense problem, and to demonstrate the usefulness of the model with a hypothetical air defense scenario. The model is unique in that it provides for employment of bistatic as well as monostatic search radars. A bistatic radar is simply a radar system in which the radar transmitter and the radar receiver are not collocated. This capability was provided to allow for the investigation of the possible advantages of the use of a bistatic radar receiver in view of the extensive capability for passive detection of active radars.

The model, acronym FADS, for Fleet Air Defense Simulation, is programmed in FORTRAN IV level G, and is designed to run on an IBM 360/65 computer meeting the core requirement of 350 kilobytes.

FADS is structured along the lines of FLOATS IIB, a model currently maintained at the Johns Hopkins University Applied Physics Laboratory [Ref. 6]. The significant differences from FLOATS IIB which have been incorporated in FADS are: bistatic search radar systems, provision for engagement of bombers by surface-to-air missiles (SAM), the addition of a surface-to-surface missile (SSM) capability for the defensive forces, a control logic which requires the defensive forces to hold fire until fired on, the inclusion of a dispersed defensive force disposition, and the

means for constructing up to six distinct target lists for the attacking units.

FADS is suitable for analysing both large scale problems and one-on-one situations in a clear or jamming environment. In general, the model provides for the description of up to 90 enemy raiders of 10 different classes, 40 defensive units of 10 different classes, 15 classes of radars, 10 classes of SAMs, 35 time delay distribution functions, and 18 logic switches are included which vary the defensive play of the simulation. During the computer debugging phase of the model construction, FADS was exercised in all of its various modes. Included among these were clear and jamming environment, single and multi threats, area and point defense, and monostatic and bistatic search radar systems.

The particular problem used to demonstrate the usefulness of the model is an investigation of the relative effectiveness of 100 nautical mile and 50 nautical mile non-fire control dedicated SAM systems deployed on picket type surface units with bistatic search radar capability. This type of SAM system employs active or passive homing throughout its entire flight. The measure of effectiveness for the respective SAM systems is the rate at which enemy air-to-surface and surface-to-surface missiles (ASM/SSM) arrive at their target area during the ASM/SSM impact phase. This is an indication of the level of the enemy attack surviving the picket defenses and will demonstrate the diminishing of the intensity of the air battle which will be

waged in the vicinity of the main force. The primary concern is to determine what effect the different missile ranges will have on breaking up this focus of an enemy ASM/SSM attack.

The analysis was conducted with hypothetical or illustrative values for all systems. Specific performance characteristics for the bistatic radar system and the missile system do not exist. Care was taken to ensure that the hypothetical values were within the range of existing systems and that the proposed systems' parameters were comparable to present system capabilities when appropriate.

Section II of the thesis contains a general description of the flow of events in FADS and a discussion of the principle assumptions in the model. The specific inputs and results of the demonstration problem together with an analysis of the results are contained in Section III. Sections IV and V provide a detailed listing of the inputs required and the outputs received from FADS. Conclusions are given in Section VI. The appendixes contain background information on bistatic radar systems, a verbal description of the simulation program, glossaries, and a FORTRAN IV computer program listing.

II. BACKGROUND AND DISCUSSION

A. GENERAL DESCRIPTION OF THE SIMULATION MODEL

FADS is a large scale store-event simulation of a Task Force size surface missile engagement with an enemy air attack. The model is capable of representing a threat consisting of a coordinated missile attack launched from aircraft, surface units or submarines. Although the model provides for defensive engagement of the enemy missiles and launch platforms with either SAM or SSM, there is no determination of defensive interceptor attrition of enemy systems during the engagement. If interceptors are to be employed, they must be played against the launch platforms prior to the start of the game and the enemy forces reduced to the appropriate level. The Air Battle Analyzer developed by the Applied Physics Laboratory of Johns Hopkins University is a suitable tool to determine these interceptor attritions [Ref. 11].

The simulation determines friendly force equipment availabilities at the start of each iteration. These availabilities are based on a comparison between user inputs of the probability that a given equipment is operational and the value of a uniform (0,1) random number which is drawn by the computer. The next step in the simulation's iterative process is to determine detections and firing events for the friendly forces against the enemy launch platforms. These

SAM/SSM fire events are stored in an events list in a time sequence. The enemy ASM/SSM launch sequence and targeting is computed next. Detections and resultant fire events against the enemy ASM/SSM's are then determined and entered in the appropriate sequence in the events list. Friendly SAM/SSM intercepts and target hits are evaluated followed by enemy ASM/SSM hits and ship kill determinations. The kill and damage events are time interactive so that offensive and defensive force capabilities are decremented as hits occur. The simulation then prints statistics for the iteration and starts the next iteration by re-entering the flow at the point where equipment availabilities are determined. The program stops upon completion of the specified number of iterations and cumulative statistics are provided.

B. ASSUMPTIONS

1. Bistatic Radar System

In the bistatic detection portion of the simulation, the principle assumptions made regarding bistatic radar systems are: a) the target's bistatic radar cross section is equal to its monostatic cross section; b) the target is not located along the transmitter-receiver base line; and c) the radar propagation losses are the same as those experienced in monostatic systems.

a. Radar Cross Section

The approximation for the bistatic radar cross section is made on the basis that, in the limit, the bistatic cross section is equal to the monostatic cross

section except for the case where the scattering angle is equal to 180° [Ref. 10, p. 590]. The scattering angle is the angle between the path from the transmitter to the target and the path from the target to the receiver. It is equal to 180° when the target is on the base line between the transmitter and the receiver. The fact that the monostatic and bistatic cross sections are the same in the limit does not imply that they are everywhere equal. It does imply that the range of the values will be equal and thus on the average allow usage of the monostatic cross section to provide representative values for detection ranges during the iterative process of the computer simulation.

b. Target Location

The assumption concerning the target not being on the base line between the transmitter and the receiver is necessary since range ambiguities result when the scattering angle is equal to 180°. This assumption is not unreasonable since the typical track may cross the base line, but will not originate on it and remain on the base line. A situation in which this could occur would be the case when a raider while on the base line launches a missile at a target which is either the transmitter or the receiver platform.

c. Propagation Losses

The assumption concerning the propagation losses is appropriate in that similar assumptions are routinely made in arriving at detection ranges for monostatic radars. A representative propagation loss for the nominal detection

range is used in conjunction with the signal to noise ratio required for a specified probability of detection to arrive at a minimum reflected power level which must be received in order for target detection to occur.

An additional assumption concerning the bistatic radar system in the simulation model is that the bistatic transmitter is always in an operative status. It is not destroyed by enemy missiles during the attack phase nor is it evaluated as being down or degraded during the equipment status evaluation which is conducted at the start of each iteration. Individual bistatic receivers have an assigned probability of being operational which should also reflect the reliability of their associated transmitter.

2. Jamming

Some major assumptions were made in simulating the jamming environment in order to keep the problem tractable and to remain within reasonable time limits for the computer program. The jamming assumptions will tend to drive the solution to conservative estimates for the defensive forces. The first assumption made is that the jammer and detecting radar have a single gain for their main beam. Thus targets not in the main beam are considered to be in a unique sidelobe which is a specified number of db below the main beam. To determine the level of the jamming power arriving at the detecting radar, it was necessary to approximate the position of the jammer relative to the detecting radar. This was done by determining the jammer's position at the time a

given target was at the midpoint of its track through the radar's detection envelope. In the case of monostatic radar this point was the target's closest point of approach. For bistatic radar the midpoint in the first detection envelope was utilized. The jamming power arriving at the detecting radar, given the geometry of this midpoint position, was then used to calculate the detection range for the target. Additionally, in the computation of bomber detections and "shoot" events, no provision is made for jammers which may have been shot down prior to the time of detection. This assumption is not required in the case of missile detections where detection events for missiles take into consideration reduction in jamming levels caused by previous destruction of jammers.

The model is limited to four frequency bands for frequency separation of individual radars in the jamming environment.

3. Target Tracks

The principle target track assumptions are concerned with minor anomalies from the real world situations. These assumptions do not detract excessively from the simulation results, but do ease computation and simplify programming. A fixed altitude for the raider and missiles, and the lack of course changes on the part of raiders are such simplifying assumptions. In the case where a raider or missile track does not change more than 0.1 nautical mile (nm) in either the x or y direction, the target is assumed to fly

parallel to the non-changing axis. If the target does not move more than 0.1 nm in both the x and y directions, the target is assumed to be stationary. Additionally, raiders who have completed their missile launches continue on their preset course rather than exiting the battle area. Although these targets will be engaged by the defensive forces if higher priority targets are not present, the resulting target hits can be readily "backed out" of the simulation results by the user if desired. On the other hand, this assumption does allow raiders that are providing standoff jamming protection for the missiles to continue to close the defensive forces and thereby increase the effectiveness of their jamming.

Other less general assumptions are covered as they occur in the details of the subroutine descriptions in Appendix B.

III. DEMONSTRATION PROBLEM

This section presents a demonstration of the use of FADS in analysing a hypothetical problem involving bistatic radar systems and surface-to-air missiles (SAM). The problem is to select the maximum range required for the SAM system to be employed by a small surface combatant (SSC). The proposed SAM system is to protect the major units of a naval task force involved in an engagement with enemy missile systems. The SSC will have a bistatic search radar and the SAMs will be active homing missiles requiring no fire control director. As such, the SSC will emit no radiation. The SAM characteristics and performance capabilities have been specified with the exception of the maximum range. Two range capabilities will be considered, a 100 nautical mile missile and a 50 nautical mile missile. The problem thus becomes that of determining the relative effectiveness of the SSC when equipped with the different range missiles. As discussed in the introduction, the measure of effectiveness used to evaluate the missiles is the number of enemy missiles penetrating to the force center per unit of time. That is, the number of missiles arriving at the force center per minute during the time period in which missiles are impacting at the force center.

A. THE SCENARIO

The BLUE force consists of one High Value Target (HVT) and eight small escorts. The BLUE force is maneuvering within range of enemy air forces. The HVT is located at force center and the pickets are equally spaced on a circle one hundred miles from the HVT. The picket force is silent except for one early warning aircraft which carries the transmitter for the bistatic radars. For purposes of this analysis, the aircraft is assumed to be at force center and at 20,000 feet.

The RED force has detected the radar transmissions of the aircraft and the HVT and have launched an attack of twenty-one aircraft accompanied by three jammers. The RED aircraft will attack simultaneously in three sections, separated by forty degrees of bearing. The RED air force has practiced this maneuver to the point that the maximum deviation from simultaneous launch will be fifteen minutes. Each aircraft will take a maximum of three minutes to launch its missiles. The three sections will approach their target from 320, 000, and 040 degrees true. The jammers will carry equipment to cover all radar bands used by the BLUE force. Each section will consist of one heavy and six light attack aircraft.

The RED air force will attempt to penetrate the BLUE defense and sink the HVT. The HVT is considered to be unarmed. In order to target a BLUE unit in this dispersed formation, a RED unit will have to have positive identification of the

unit as hostile. An ECM fix, or visual ID will be adequate. As the BLUE pickets are not radiating, no ECM fix may be obtained. As the pickets are assumed to be smaller than a destroyer escort, and the RED aircraft will fly at a minimum altitude of 33,000 feet, no positive visual identification will be allowed.

The radio and radar silence of the pickets leaves them without the ability to coordinate their defense. No BLUE intercept will be allowed if the intercept point is within two miles of another BLUE unit's assigned position. The BLUE units will use a shoot-look-shoot doctrine.

B. THE INPUTS

1. The Units

a. The BLUE Units

The BLUE units consist of the HVT, eight pickets, and one early warning aircraft. Positions are as indicated in the scenario.

(1) HVT. For the purpose of this analysis the HVT is assumed to be unarmed.

(2) Pickets. The pickets will employ a type 4, bistatic, band 4 radar with an antenna height of 50 feet. They will carry thirty missiles in canisters. The probability of a correct target identification will be .95.

(3) Early Warning Aircraft. The BLUE early warning aircraft will be unarmed. It will carry a type 4 radar and serve as the transmitter for the pickets' bistatic receiver.

b. The RED Units

The three classes of RED units are heavy attack, light attack and jammers.

(1) *Heavy Attack*. The RED heavy attack aircraft will carry a type 5 radar and have the following characteristics.

WEAPONS: 1 type I ASM
4 type II ASM

SPEED: 415 Knots

JAMMERS: none

RADAR CROSS SECTION: 40 square meters

ALTITUDE: 35,000 feet

(2) *Light Attack*. The RED light attack aircraft will carry a type 5 radar and have the following characteristics.

WEAPONS: 2 type II ASM

SPEED: 420 Knots

JAMMERS: none

RADAR CROSS SECTION: 13 square meters

ALTITUDE: 33,000 feet

(3) *Jammers*. The RED jammer will carry no radar. It will have the following characteristics.

WEAPONS: none

SPEED: 417 Knots

JAMMERS: bands 1-4
250 watts/MHZ/band
359° beam width
-20 db side-lobe ratio
jamming target, HVT

RADAR CROSS SECTION: 32 square meters

ALTITUDE: 40,000 feet

2. The Radars

The two radars which the simulation will use to play the simulation are the class 4 and class 5 radars. Class 4 radars are found on all pickets and class 5 on all raiders.

a. Class 4 Radar

TYPE: Bistatic

β: 120 $nm/m^{\frac{1}{2}}$

α: 30 $nm/m^{\frac{1}{2}}$

SIDE LOBE RATIO: -20 db

MAXIMUM INSTRUMENTED RANGE: 200 miles

RADAR FREQUENCY BAND: 4

BEAM WIDTH: 10 degrees

TRANSMITTER UNIT: aircraft overhead HVT

TRANSMITTER ANTENNA HEIGHT: 20,000 feet

b. Class 5 Radar

TYPE: Monostatic

β: 100 $nm/m^{\frac{1}{2}}$

α: 50 $nm/m^{\frac{1}{2}}$

SIDE LOBE RATIO: -20 db

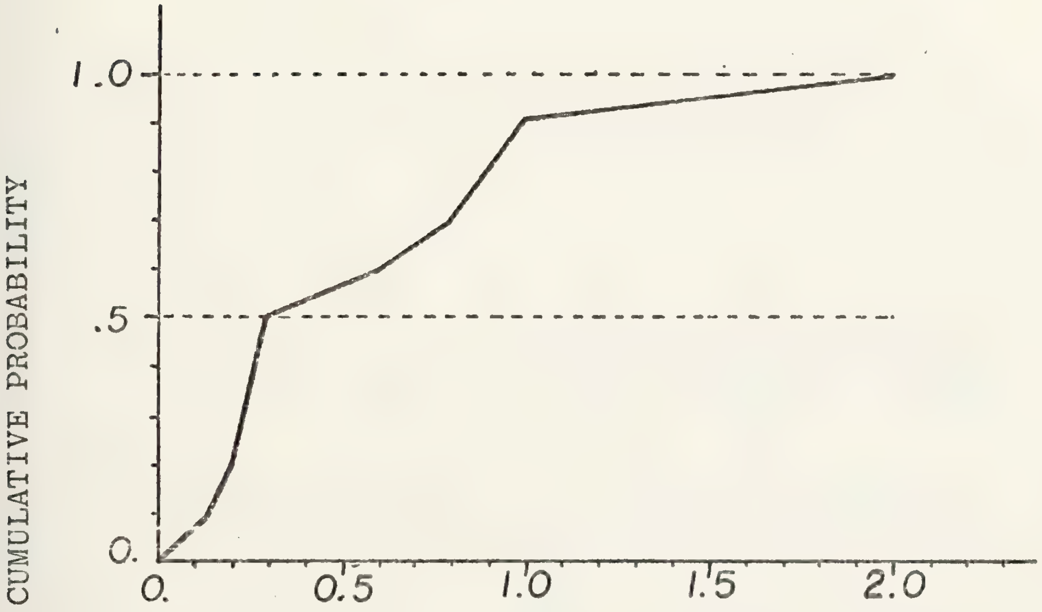
MAXIMUM INSTRUMENTED RANGE: 200 miles

RADAR FREQUENCY BAND: 3

BEAM WIDTH: 3 degrees

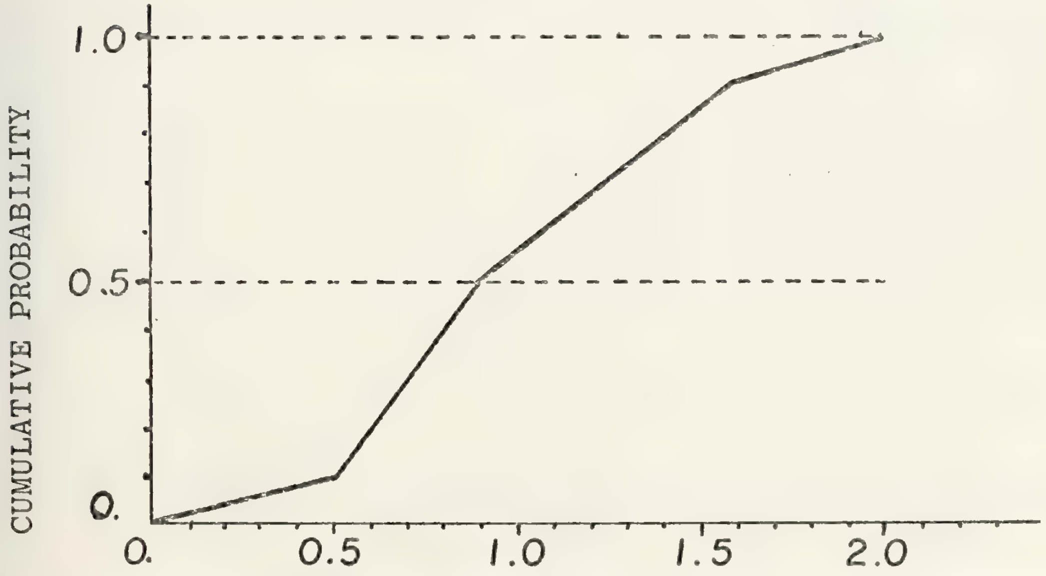
3. The Reaction Time Distributions

The reaction time distributions for target processing by the picket are displayed below.



DETECTABILITY TO DETECTION DELAY IN MINUTES

Figure 1



DETECTION TO ID AND DESIGNATION TO WEAPONS EQUIPMENT

Figure 2

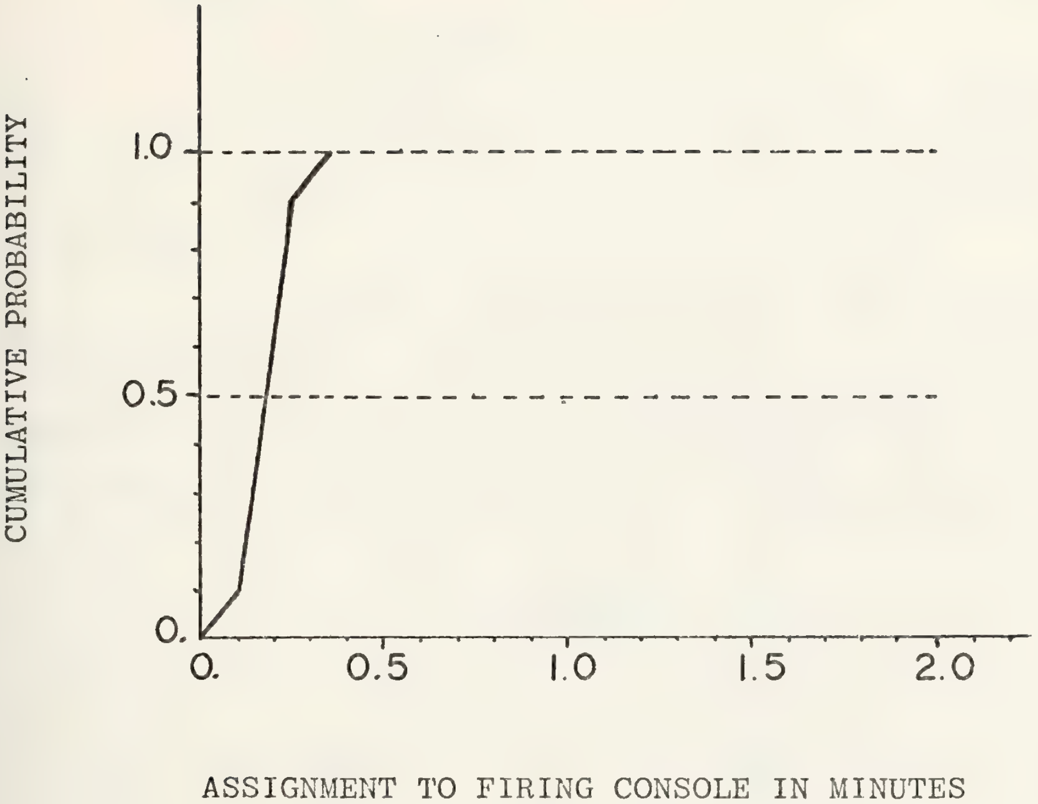


Figure 3

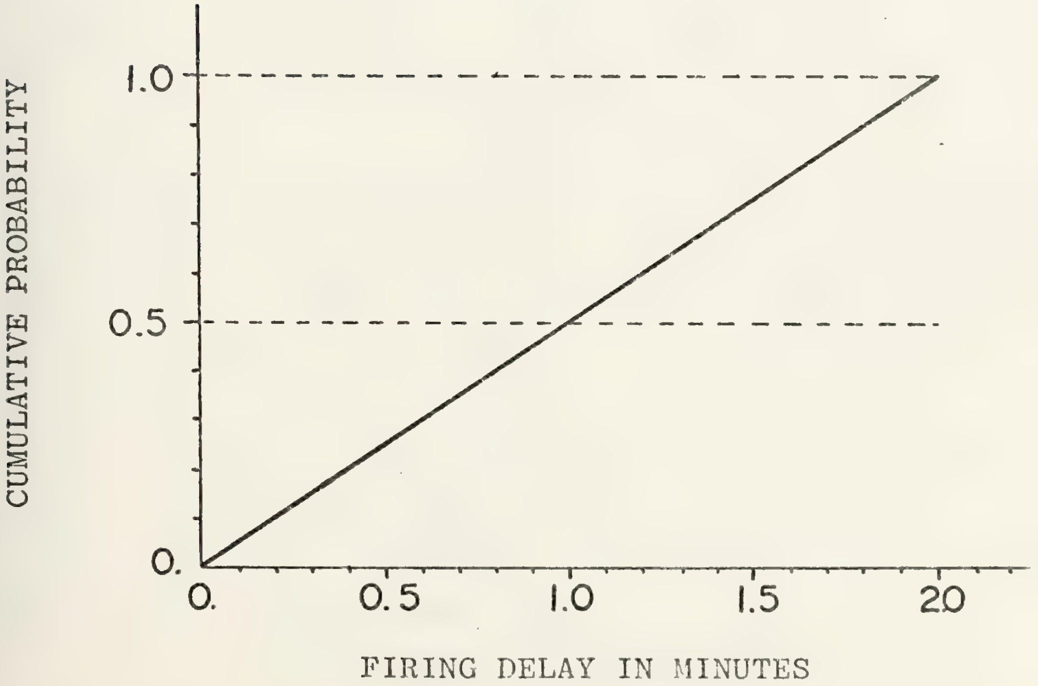


Figure 4

4. The Weapons

a. The BLUE Weapons

There are two types of BLUE weapons. Both are SAMs and are denoted as SAM LR (long range) and SAM SR (short range).

(1) SAM LR. This will be the 100 mile version of the BLUE missile. It will have two sets of intercept parameters. The first is for a large, slow, high flying target. The second is for a small, fast, medium altitude target.

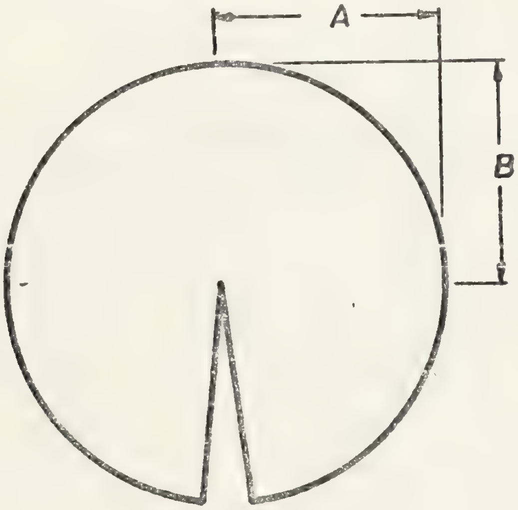


Figure 5

SAM Intercept Contour for High Altitude Engagement

The input value for the SAM LR class are:

A = 100

B = 100

N = 2.0

SLOPE = -20

SEEK = -5

SPEED = 1400 Knots

PROBABILITY KILL FOR SINGLE SHOT (PKSS) = .88

PKSS (CROSSING) = .79

SYSTEM RELIABILITY = .95

LAUNCH RELIABILITY = .99

MAXIMUM ALTITUDE = 59,000 feet

MINIMUM RANGE = 0.5 miles

The intercept parameters A, B, N, SLOPE, and SEEK are defined in the description of subroutine TIMMY in Appendix B.

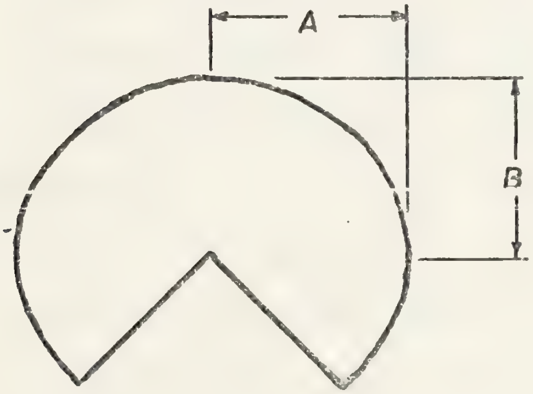


Figure 6

SAM Intercept Contour for the Medium Altitude Engagement

A = 100

B = 90

N = 2.8

SLOPE = -1

All other parameters are the same as high altitude engagement

(2) <u>SAM SR</u>. This will be the 50 mile version of the BLUE missile. The intercept contours will be the same as those for the SAM LR except the down range and cross range values are half the SAM LR values.

b. The RED Weapons

The RED aircraft carry two types of ASMs.

(1) <u>ASM Type I</u>.

SPEED: 750 Knots

ALTITUDE: 20,000 feet

LAUNCH RANGE: 120 miles

LAUNCH RELIABILITY: 0.85

INFLIGHT RELIABILITY: 0.80

RADAR CROSS SECTION: 1.79 square meters

(2) <u>ASM Type II</u>.

SPEED: 900 Knots

ALTITUDE: 15,000 feet

LAUNCH RANGE: 110 miles

LAUNCH RELIABILITY: 0.85

INFLIGHT RELIABILITY: 0.9

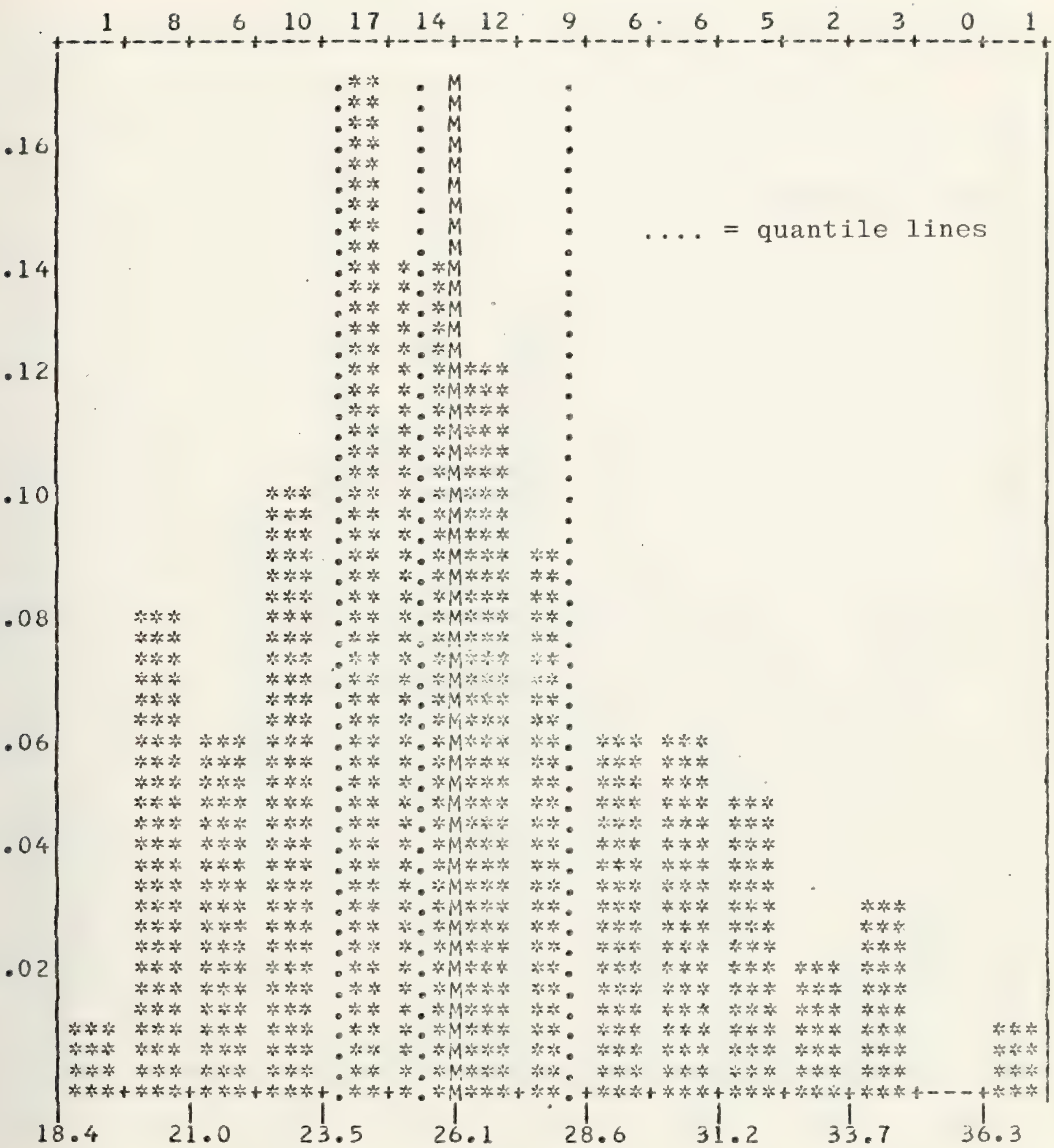
RADAR CROSS SECTION: 1.01 square meters

C. RESULTS

A summary of the results for 100 iterations is presented below.

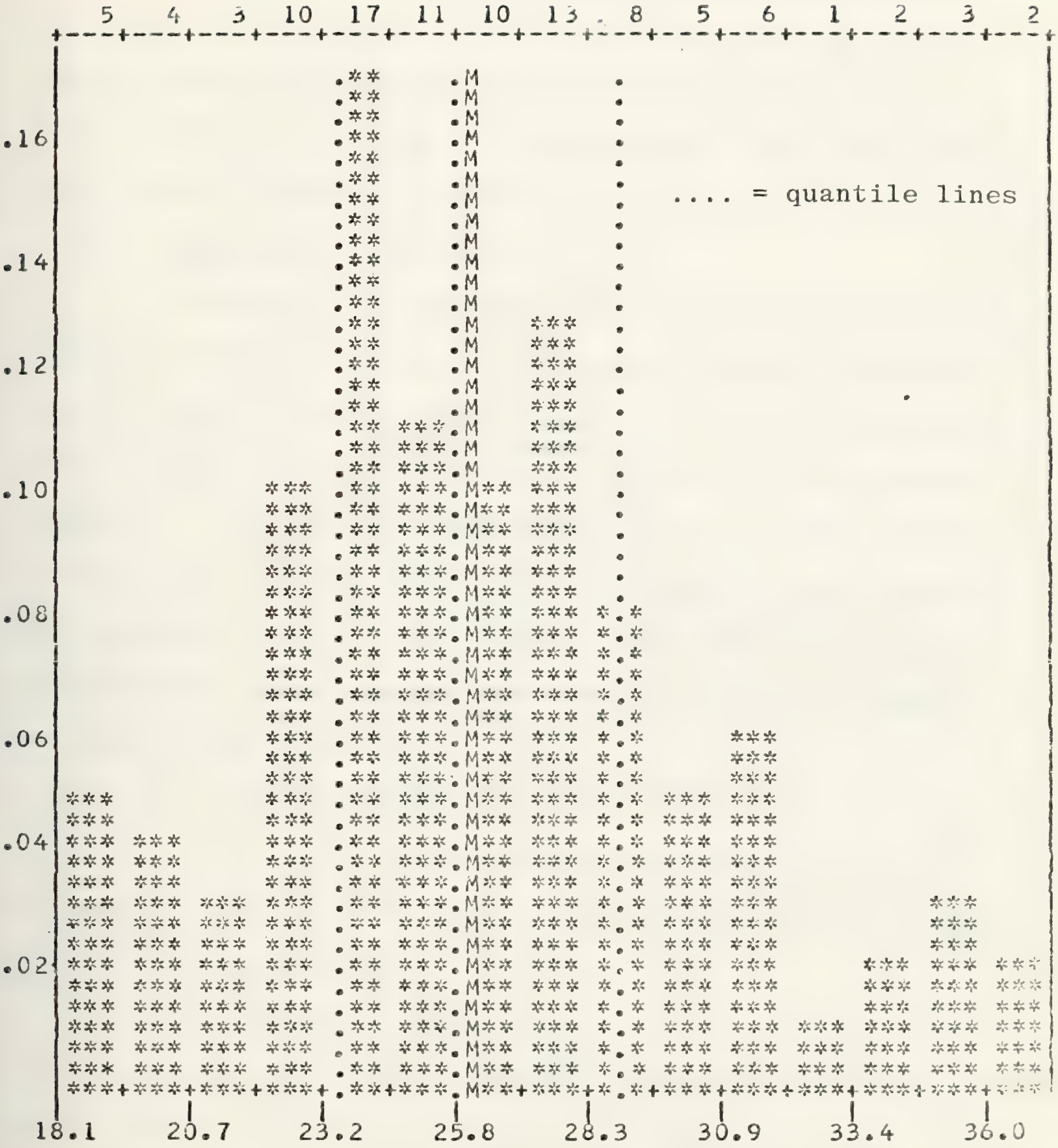
1. ASM Results.	SAM SR	SAM LR
Available	5100	5100
Destroyed with launch platform	172 (3.4%)	246 (4.8%)
Launched	4928 (96.6%)	4854 (95.2%)
Failed at launch	724 (14.7%)	750 (15.4%)
Failed in flight	429 (8.7%)	418 (8.6%)
Destroyed by SAMs	0	0
Impact on HVT	3775 (76.6%)	3686 (75.9%)
2. SAM Results.		
Available	24000	24000
Launched	3401	6440
Kills	2116 (62.2%)	2398 (37.2%)
ASM	0	0
Raiders	2116	2398
Overkills	605 (17.8%)	2694 (41.8%)
Failures	680 (20.0%)	1348 (20.9%)
3. ASM Impact Intervals (minutes).		
Mean	1.468	1.432
Variance	0.033	0.037
Skewness	-0.060	0.070
Kurtosis	-0.620	-0.532
Minimum	1.091	0.966
Maximum	1.849	1.862
4. ASM Impacts per Minute.		
Mean	26.101	26.192
Variance	14.651	17.541
Skewness	-0.584	0.453
Kurtosis	-0.006	-0.136
Minimum	18.422	18.129
Maximum	37.567	37.246

5. Histograms of the ASM impacts per minute are shown in Figures 7 and 8.



Histogram of the ASM Impacts per Minute, SAM SR

Figure 7



Histogram of the ASM Impacts per Minute, SAM LR

Figure 8

D. ANALYSIS

The analysis of the results consists of three parts. The first part contains a parametric evaluation of the ASM impacts per minute for the two SAM systems. The second part provides a nonparametric evaluation. Part three provides general comments concerning anomalies in the results.

1. Parametric Evaluation

The purpose of the parametric evaluation is to test whether the mean ASM impacts per minute against the SAM SR (u_{50}) is significantly greater than the mean ASM impacts per minute against the SAM LR (u_{100}). With its shorter range capability, the SAM SR system should attain a lower number of kills than the SAM LR system. Consequently the number of ASM impacts on the HVT that occur during the defense by the SAM SR system should be greater than the number of impacts during the SAM LR defense.

a. Null Hypothesis

H_0: $u_{50} \leq u_{100}$; SAM SR effectiveness is equal to or greater than the SAM LR system's as indicated by the mean ASM impacts per minute.

b. Alternative Hypothesis

H_1: $u_{50} > u_{100}$; SAM SR is less effective than SAM LR and therefore has a higher mean ASM impacts per minute.

c. Significance Level

A significance level of 0.05 was used in testing H_0.

d. Statistical Test

The null hypothesis was tested against the alternative hypothesis using a t test. The t statistic for testing equal means is:

$$t = \frac{\bar{x}_{50} - \bar{x}_{100}}{\left[\frac{n_{50}+n_{100}}{n_{50}n_{100}}\right]^{\frac{1}{2}} \left[\frac{n_{50}s_{50}^{2}+n_{100}s_{100}^{2}}{n_{50}+n_{100}-2}\right]^{\frac{1}{2}}}$$

where:

$\bar{x}_{50}$ = sample mean for SAM SR. (26.10)

$\bar{x}_{100}$ = sample mean for SAM LR. (26.19)

s_{50}^{2} = sample variance for SAM SR. (14.651)

s_{100}^{2} = sample variance for SAM LR. (17.541)

$n_{50}= n_{100}=$ number of samples for SAM SR and SAM LR. (100)

The null hypothesis will be rejected if the computed test statistic t is greater than or equal to the table value for the 0.95 point of t distribution with 198 degrees of freedom. The table value is:

$$t_{.95,198} = 1.96$$

e. Decision

The computed test statistic is t = -0.1578. Since the computed t ratio is less than the tabulated value, the null hypothesis cannot be rejected at the 0.05 level.

f. Conclusion

The effectiveness of the SAM SR system was equal to or greater than the effectiveness of the SAM LR system at the 0.05 level of significance.

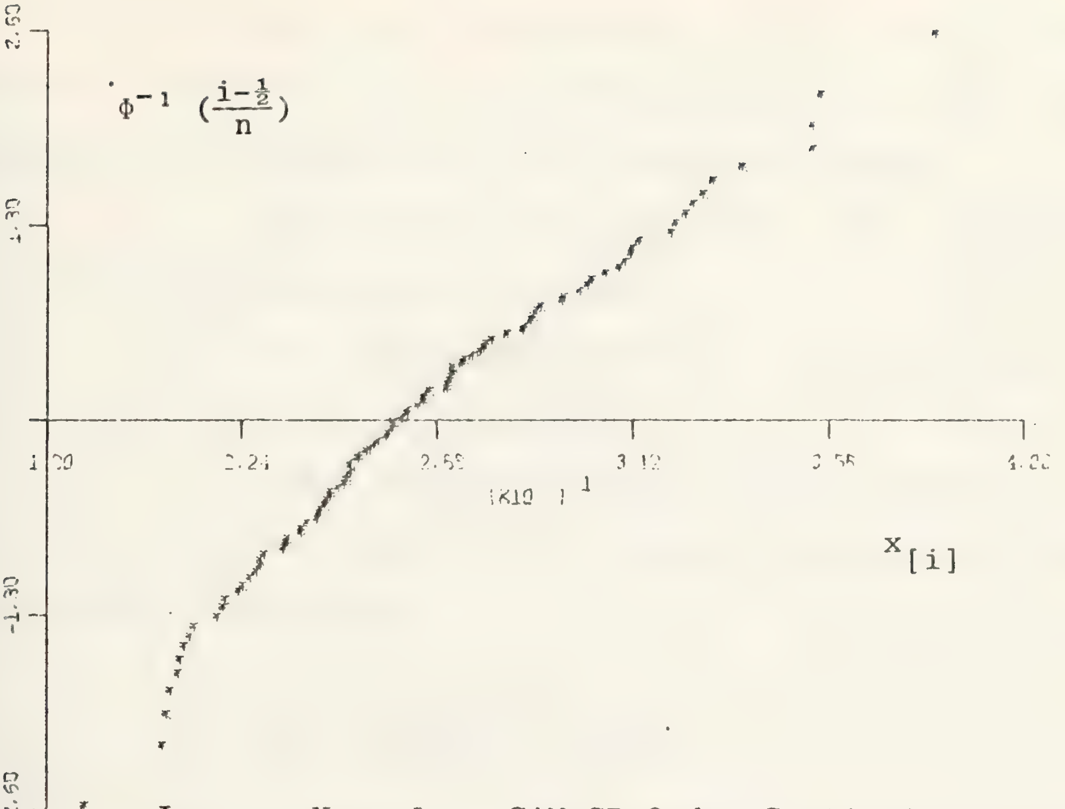
g. Justification for Use of the t Test

In order to use the t test for difference in means, three basic conditions had to be met. These were: i) the sample means were independent; ii) the underlying distributions from which the samples were drawn was normal; and iii) the underlying distributions had equal variances.

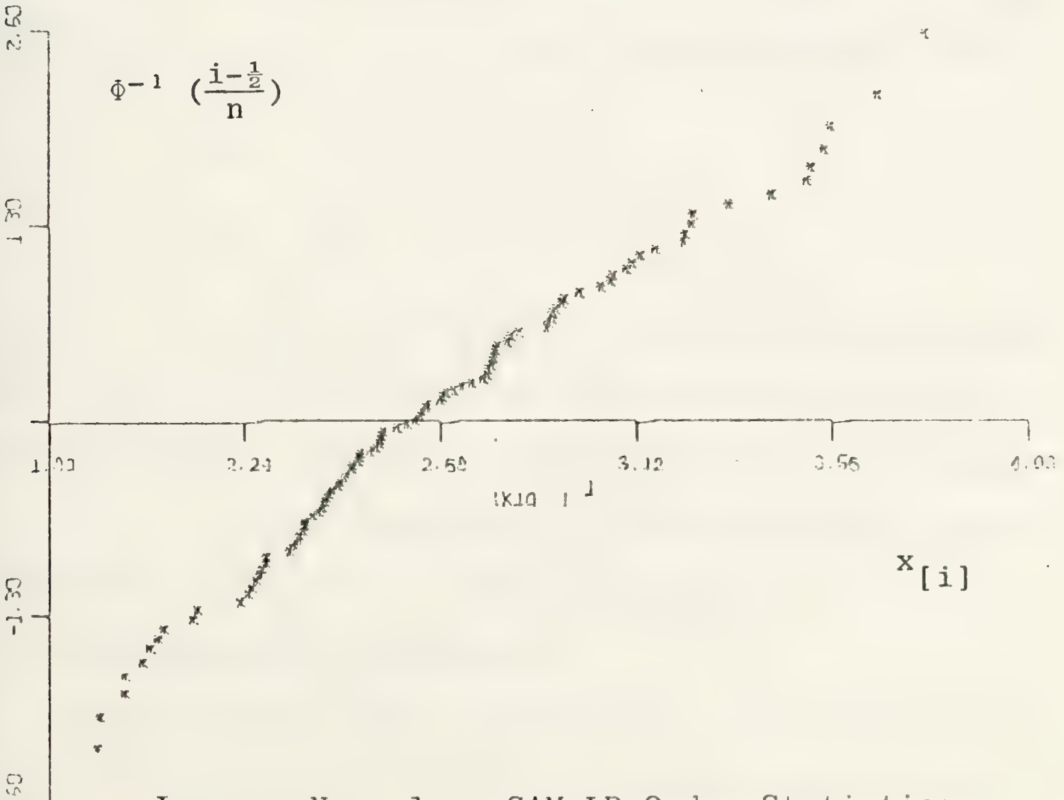
(1) Independence. The independence of the sample means was a reasonable assumption since the individual samples were obtained from different simulation runs using different random number streams.

(2) Normality. The normality of the sample mean values could be asserted on the basis of the sample size (100) and the central limit theorem or by demonstrating that the means were computed from samples which came from a normal distribution. The underlying normal distribution can be shown on the basis that both samples were unimodal and symetric, and that the plots of their order statistics against the inverse normal probability scale was linear. The unimodality of the samples is seen in the histograms in figures 7 and 8. Symmetry is evident in both histograms and supported by the fact that the kurtosis of the sample values is close to zero. The order statistic plots, which are clearly linear, are shown in figures 9 and 10.

(3) Equal Variance. The relationship between the variance of the population from which the samples were drawn is tested using the F ratio. This test is applicable since the populations are normally distributed.



Inverse Normal vs SAM SR Order Statistics
Figure 9



Inverse Normal vs SAM LR Order Statistics
Figure 10

(a) Null Hypothesis. $H_0: \sigma^2_{50} = \sigma^2_{100}$; the population variance (σ^2_{50}) of the SAM SR system is equal to the population variance (σ^2_{100}) of the SAM LR system.

(b) Alternative Hypothesis. $H_1: \sigma^2_{50} \neq \sigma^2_{100}$; the population variances are not equal.

(c) Significance Level. A significance level of 0.05 was used in testing H_0.

(d) Statistical Test. H_0 was tested against H_1 using the ratio of the unbiased estimators of the two population variances.

$$F = \frac{s^2_{100}}{s^2_{50}} = \frac{17.541}{14.651} = 1.1973$$

The null hypothesis will be rejected if the computed ration F is greater than the tabulated value of $F_{(1-\alpha/2;\ 99,\ 99)}$ or less than $F_{(\alpha/2;\ 99,\ 99)}$. The tabulated values are:

$$F_{(.975,\ 99,\ 99)} = 1.451$$

$$F_{(.025,\ 99,\ 99)} = 0.684$$

(e) Decision. Since the computed ratio F is not greater than or less than the tabulated values for the F distribution, the null hypothesis cannot be rejected.

(f) Conclusion. The samples were drawn from populations which had equal variances.

2. Nonparametric Evaluation

The purpose of the nonparametric evaluation is to test whether the sample values for the SAM SR system and the SAM LR system are from the same population.

a. Null Hypothesis

H_0: There is no difference in the number of ASM impacts per minute when defending with the SAM LR system or with the SAM SR system.

b. Alternative Hypothesis

H_1: There is a difference.

c. Significance Level

A significance level of 0.05 was used in testing H_0.

d. Statistical Test

The Kolmogorov-Smirnov (K-S) two-sample test was used to test the null hypothesis. The K-S test requires the use of independent samples. Independence was shown in D.1.g.(1) above. The K-S test is conducted using the statistic

$$K = \max \left| F_n(X) - G_m(Y) \right|$$

where $F_n(X)$ is the empirical cumulative distribution function for the first set of sample values and $G_m(Y)$ is the empirical cumulative distribution function for the second.

The null hypothesis will be rejected if there is a large enough deviation between the two sample cumulative distributions. The critical values of D for the level of significance of 0.05 and 100 observations in each sample is 0.19233.

e. Decision

The computed value of K was determined to be 0.0800. Since the computed value of K is less than the tabulated critical value, the null hypothesis cannot be rejected at the 0.05 level. A plot of the empirical cumulative distribution functions for the two sets of sample values is provided in figure 11. This plot clearly shows the close relationship between the two underlying populations.

f. Conclusion

There was no difference in the defensive capabilities of systems in the environment in which they were examined.

3. General Comments

The principal anomalies present in the data include the following:

a) a lack of difference in the SAM LR and SAM SR effectiveness;

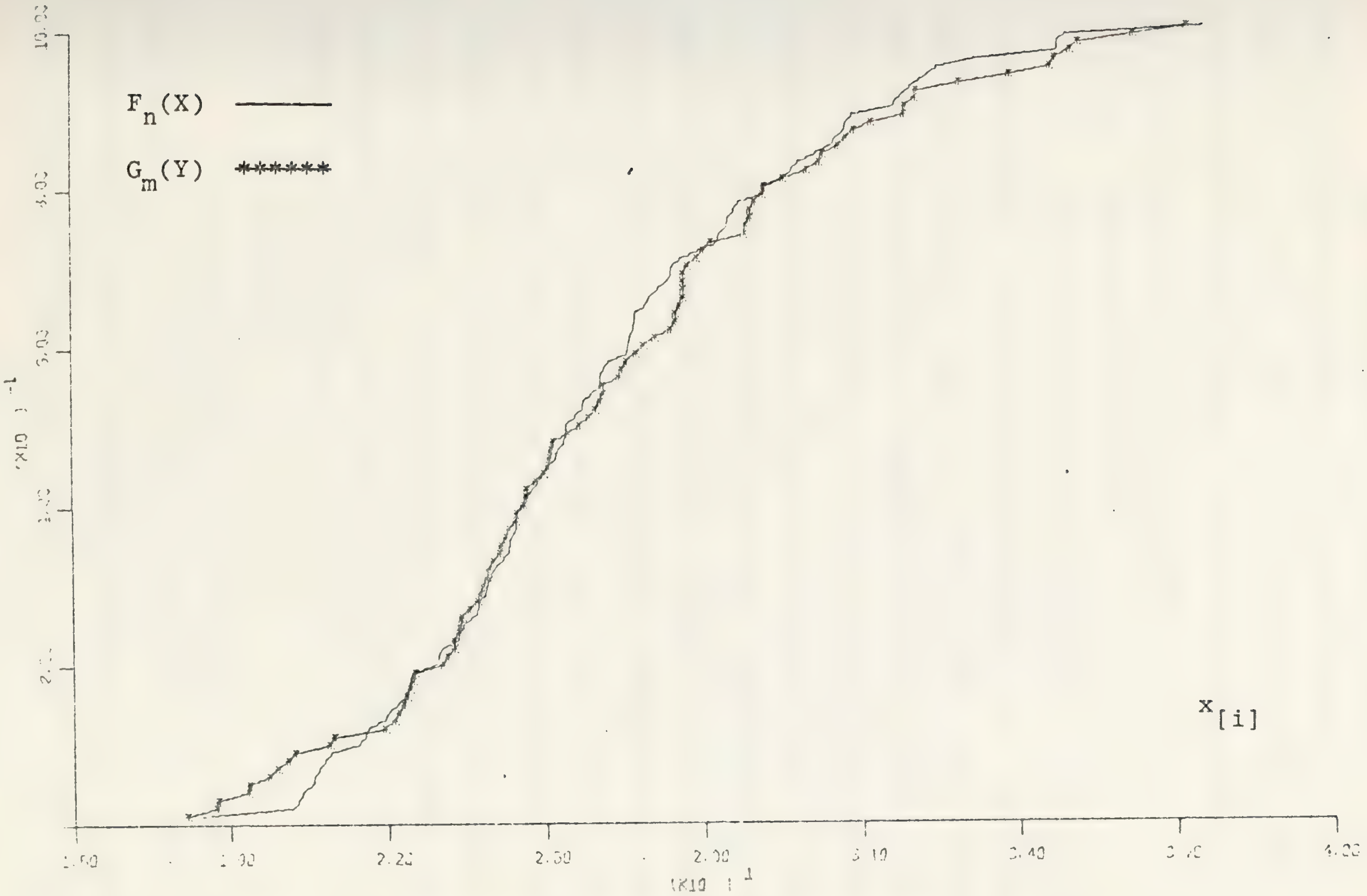
b) no SAM kills of ASMs;

c) a greater number of overkills for the SAM LR;

d) the number of SAM failures; and

e) the short ASM impact interval.

These anomalies do not significantly detract from the conclusions presented in the parametric and nonparametric evaluations.



Plot of Empirical Cumulative Distribution Function for Both SAMs.

Figure 11

a. Lack of Difference in Effectiveness

The most probable reason for the lack of difference in the effectiveness of the two SAM systems was the jamming environment. The reduced detection ranges experienced in jamming will tend to preclude the use of SAMs at the longer ranges available to the SAM LR system.

b. No SAM Kills of ASMs

The lack of SAM kills of ASMs was primarily due to the geometry of the ASM launch positions and the program logic concerning SAM targeting. The program logic requires that the closest target be considered as most threatening and therefore engaged first. In the problem, the ASM launch positions were less than 10 miles from their point of closest approach to the SAM ship positions. Consequently, the ASMs with their greater speed were closer than the raiders to the SAM ships for only the first 30 seconds after their launch. After that period, their speed caused them to be at a greater range from the SAM ship. Thus the SAM ships had a 30 second period in which to detect, acquire, and designate an ASM as the most threatening target. The reaction time distributions for the SAM ships precluded such a short reaction time in most cases.

c. Overkills

The higher number of overkills for the 100 mile SAM was due to the longer flight time of the SAM. This coupled with a lack of coordination resulted in a greater opportunity for another unit to obtain a kill on the target

while a second SAM was in flight. Targets that had been destroyed prior to the scheduled SAM launch time were not engaged.

d. SAM Failures

The number of SAM failures includes SAMs which were fired on the ASMs that impacted on the HVT while the SAM was in flight. These attempted engagements occurred since the SAM units were not given the capability to determine the ASM impact point.

e. Short ASM Impact Interval

The tightness of the ASM impact interval may appear to be pessimistic in relation to a real world threat. However, this should not detract from the comparison of the two SAM systems.

IV. MODEL INPUTS

The inputs required to use FADS fall into three groups. These are the X vector, the target list assignments, and the target lists themselves. The amount of actual input required depends upon the size of the problem to be analyzed.

A. THE X-VECTOR

All X vector inputs are real values and are read into the X vector in the following way. Each input card must contain six numbers. The first number is the integer address in the X vector. This integer should be placed in columns 1-10, right justified. The remaining five numbers are the values to be inserted in the five X vector positions beginning with the position indicated in columns 1-10 of the input card. The format for each card with X vector data is (I10,5F10.3). If there are no data to be read into a position, no input is required, unless the position falls within the scope of another input card. The end of the X vector inputs is signaled by the inclusion of a zero card. This card contains a zero in column '10 and zeros in the five data positions. A brief overview of the organization of the input array is provided below. Details concerning the individual sub-sections are provided at the beginning of each sub-section. Specifics dealing with the input values are discussed in the description of the particular input value and as footnotes to the individual sections.

The following is the organization of the input X vector:

X(1) to X(100), Control switches and program constants

X(101) to X(500), Ship Classes

X(501) to X(900), SAM Classes

X(901) to X(1200), Radar Classes

X(1201) to X(1400), Ship Positions

X(1401) to X(1800), Delay Functions

X(1801) to X(2000), Raid Classes

X(2001) to X(2200), Raid Weapon Classes

X(2201) to X(2740), Initial Raider Positions.

1. Control Switches

These inputs include logic switches for varying the general play of the game. They also provide the means for constrolling the output in the form of debug and array printout switches. Several of the control switches are related to inputs for specific systems which appear in later sections and must be consistent with later usage. Other portions of this input section are used to store values for generating statistics and for internal use by the model. These portions should not have inputs since their value will be set as required by the model.

X( )	Inputs
1	Case number
2	Blue force equipment availability switch: 0 = 100% availability 1 = use input availabilities

X( )	Inputs
3	Blue force radar detection range printout in Event 2: 0 = no print 1 = print
4	Fleet coordination of Blue forces: 0 = none 1 = coordinated defense
5	Blue ship out of action after N hits: 0 = yes 1 = no (N is a ship class input)
6	Number of iterations. (Must be at least 1. If X(85) used, must be at least 10 and less than 101.)
7	Horizon/Sector Scan for Blue fire control radar system enabled: 0 = no 1 = yes if equipment capable
8	Blue SAM Sector enable: 0 = don't use sectors 1 = sectors used
9	Print control: 0 = none 1 = selected output tables and intermediate debug printouts. Set to 0 by the model after first iteration.
10	Detectability to detection delay: 0 = use input distribution function 0.XX = a fraction; time for Raider or ASM to move this portion of calculated detection range.
11	ISEED value. Initial seed value used in generation of random numbers. Can be up to a seven digit number.
12	X-array print out switch: 0 = no print 1 = print out X-array as read in, target lists, and target list assignments.
13	Random number counter. Set to 0 by model. Maintains running count of random numbers drawn.

X( )	Inputs
14	Total number of random numbers used. Computed by model.
15	Converted X-array print out switch: 0 = no print 1 = print out X-array as converted by model.
16	Blue first shoot control: 0 = Blue may fire as soon as Red detected. 1 = Blue may only fire after first Red missile launch.
17	Number of jamming raiders: 0 = no jammers 1 = one jammer 2 = two jammers, etc.
18-19	Spares
20	Altitude in feet above which a raider will be considered as being at "high altitude" for purposes of obtaining a visual identification of a non-radiating picket.
21	Probability of "high altitude," from X(20), raider launching ASM at a non-radiating picket.
22	Probability of "low altitude," below X(20) input, raider launching ASM at non-radiating picket.
23	Maximum range (nautical miles) at which a raider is able to obtain a visual identification of a Blue surface unit.
24	Geographical plots: 0 = no plots required 1 = print plot of Blue positions 2 = print plot of raider tracks 3 = print both plots
25-50	Spares
(51-60)	(Debug switches - cleared at end of first iteration a printout will occur if input value is 1.)
51	Ship table.
52	Raid table.
53	SAM table.

X( )	Inputs
54	Random numbers used.
55	Subroutine login/logout.
56	SAM/ASM engagement, ASM impact, and SAM kill.
57	ASM detection data.
58	Closest point of approach and IBAT data.
59	SAM-ASM Intercept data (angles).
60	Store and Get Event Log.
(61-70)	(Statistics generated by the model, ignore for input.)
61	Total ASM's fired for all iterations.
62	Total ASM's failed at launch.
63	Total ASM's killed by SAM's.
64	Total ASM's failed in flight.
65	Total ASM's destroyed with launch platform.
66	Total SAM launches.
67	Total SAM failures.
68	Total SAM overkills.
69	Total ASM successfully launched.
70	Total ASM hits.
71-74	Spares
75	Number of SAM rounds remaining in Fleet. Internal use by the model.
76	Hazard zone radius, nm. If predicted intercept of target is within this range of another ship, then the firing ship must hold fire until the predicted intercept point has moved beyond this range.
77	Breakpoint altitude, ft, used to select proper SAM velocities, ranges, and intercept contours, for "high" or "low" SAM contours.

X( )	Inputs
78	Ship position inputs coordinate system: 0 = Polar (000 True is Y axis). 1 = Cartesian (X = ; Y =).
79-80	Spares
81	Radar horizon factor (default value 1.23).
82	End of game time (default value 120 min).
83	Launch interval for one raid, min.
84	Launch interval for all raids, min.
85	Number of ship for which the display of hit frequency and hit interval is desired. Enter 0 if analysis is not desired or if the number of iterations is less than 10 or greater than 100, in which case the histogram can not be generated by the model.
86	Interval for initial launch of Red SSM's, min.
87	Recognition delay, in minutes, for stationary Red raiders. For use when X(10) is not zero.
88	Number of ships.
89	Number of raiders (including Red aircraft which are only jammers, those without weapons, and Red surface/subsurface units).
90-100	Spares

2. Ship Class Inputs

The different types of BLUE ships in the simulation are specified by the ship class inputs. Included under one listing are all of the ships of a particular class (e.g. DDG, CG, FFG) which possess similar weapons and detection capabilities. A maximum of 10 different classes may be used. Ship class 1 is input into X(101) to X(140); ship class 2 into X(141) to X(180); etc.

X( )	Inputs
101	SAM/SSM battery #1 class[1]
102	Sam/SSM battery #2 class
103	SAM/SSM battery #3 class
104	SAM/SSM battery #4 class
105	Search radar #1 class number[2]
106	Search radar #2 class number
107	Search radar #3 class number
108	Search radar #1 antenna height (ft)
109	Search radar #2 antenna height (ft)
110	Search radar #3 antenna height (ft)
111	Fire control radar #1 antenna height (ft)
112	Fire control radar #2 antenna height (ft)
113	Fire control radar #3 antenna height (ft)
114	Fire control radar #4 antenna height (ft)
115	Coordination capability for this ship class: 0 = none (override) 1 = coordination X(14) if fleet coordination is in use.
116	Probability of correct identification and designation to Weapon Direction Equipment (WDE).
117	Class of RTDF #2 (detection to ID and designation to WDE).

---

[1] Enter 1 if the battery has SAM/SSM's where class inputs are listed in X(501) to X(540); enter 2 if SAM/SSM inputs are in X(541) to X(580); etc.

[2] Enter 1 if the search radar class inputs for the respective search radar are contained in X(901) to X(920); enter 2 if the search radar class inputs are in X(921) to X(940); etc. Note that the Fire Control Radar class is listed with its associated SAM class inputs.

X( )	Inputs
118	Class of RTDF #3 (designation to assign FCS).
119	Class of RTDF #5 (firing delay).
120	Class of RTDF #7 (decisional delay for horizon/sector scan mode -- used with X(7)).
121	Number of hits required to put ship out of action.
122	Left SAM battery #1 launcher train angle limits (deg. true).
123	Right SAM battery #1 launcher train angle limits (deg. true).
124	Left SAM battery #2 launcher train angle limits (deg. true).
125	Right SAM battery #2 launcher train angle limits (deg. true).
126	Left SAM battery #3 launcher train angle limits (deg. true).
127	Right SAM battery #3 launcher train angle limits (deg. true).
128	Left SAM battery #4 launcher train angle limits (deg. true).
129	Right SAM battery #4 launcher train angle limits (deg. true).
130	Ability to determine target at which an ASM has been fired: 0 = No 1 = Yes
131	Designation for non-radiating picket units using bistatic radar: 0 = No; unit will be targeted using only the normal target list algorithm. 1 = Yes; unit will be targeted using both the normal target list algorithm and the additional algorithm for non-radiating pickets. If some bistatic units are to be used in the main force, a separate ship class must be entered for them.
132-140	Spares

X( )	Inputs
141-180	Ship class 2
181-220	Ship class 3
221-260	Ship class 4
261-300	Ship class 5
301-340	Ship class 6
341-380	Ship class 7
381-420	Ship class 8
421-460	Ship class 9
461-500	Ship class 10

3. SAM/SSM Class Inputs

These inputs specify the BLUE SAM/SSM system capabilities in terms of missile flight characteristics, fire control radar class, salvo firing doctrine, missile reliabilities and kill probabilities. A maximum of 10 different SAM/SSM classes may be input. SAM/SSM class 1 is input into X(501) to X(540); SAM/SSM class 2 into X(541) to X(580); etc.

X( )	Inputs
501	Max range, nm, against "high" altitude target.
502	Average speed, knots, for expected intercept range against "high" altitude target (converted by the model to nm/min).

X( )	Inputs
530	A, nm, "high" altitude target[3]
504	B, nm, "high" target[3]
505	N, for "high" target[3]
506	SLOPE against "high" target[3]
507	SEEK, nm, for "high" target[3]
508	Max range, nm against "low" altitude target
509	Average speed, knots, against "low" altitude target (converted by the model to nm/min).
510	A, nm, against a "low" target
511	B, nm, against a "low" target
512	N, for "low" target
513	SLOPE for "low" target
514	SEEK, nm, for "low" target
515	Minimum range, nm
516	Maximum altitude, ft
517	Number of Fire Control Radar (FCR) channels for FCR Type 1. (0 = missile not requiring a dedicated fire control system.)
518	Class of FCR - Type 1
519	Number of FCR channels for FCR Type 2
520	Class of FCR - Type 2
521	Number of FCR channels for FCR Type 3
522	Class of FCR - Type 3

---

[3] The definitions of A, B, N, SLOPE, and SEEK are contained in the description of subroutine TIMMY in Appendix B.

X( )	Inputs
523	Horizon sector scan capability for fire control radars: 0 = No (used when X(7) set) 1 = Yes input as XXX = unit digit FCR Type 1 ten digit FCR Type 2 hundred digit FCR Type 3
524	Number of SAM's per salvo
525	Launch cycle time, min
526	Probability that launcher is available (used only when X(2) is set to 1).
527	Magazine size
528	Spare
529	Probability of single-shot kill
530	System reliability
531	Reliability (launch, guidance, and fuse)
532	Terminal guidance time, min (if HAW set to 0).
533	Kill assessment time, min
534-535	Spares
536	Flag for Blue surface to surface missiles: 0 = SAM 1 = SSM
537	Single shot kill probability for a crossing target
538-540	Spares
541-580	SAM Class 2
581-620	Sam Class 3
.	.
.	.
.	.
861-900	SAM Class 10

4. Radar Class Inputs

Search and fire control radars for both BLUE and RED units are specified in this section of the inputs. Search radars classes are related to the ship class and raid class inputs. The fire control radars are used with the appropriate SAM/SSM class inputs although their antenna heights are contained in the ship class inputs. The radars are specified on the basis of their detection capabilities, beam widths, side-lobes, radar frequency, and delay functions. In the case of a bistatic radar, the location and antenna height of the transmitter must also be specified. A maximum of 15 radar classes may be included. Radar class 1 is input into X(901) to X(920); radar class 2 in X(921) to X(940); etc.

X( )	Inputs
901	Radar Type: 0 = Bistatic 1 = Monostatic
902	β, detection range in clear environment, nm/m$^{\frac{1}{2}}$ (see Appendix C).
903	α, detection range with standoff jamming of lw/mhz, nm/m$^{\frac{1}{2}}$ (see Appendix C).
904	Side-lobe ratio. Number of db that average side-lobe is below main beam. Enter as a negative number. Converted by model to side-lobe coefficient for use in obtaining jamming effects.
905	Maximum instrumented range, nm.
906	Class of reaction time distribution function: Detectability-to-detection for search radars. FCS assigned to acquisition for fire control radars.

X( )	Inputs
907	Radar frequency band index. 1, 2, 3, or 4. Used with jamming to provide for frequency differences in various radars.
908	Class of reaction time distribution function for fire control radars: Detectability to detection delay in horizon/sector scan mode. Blank for search radars.
909	Max Director assignment range for FCR, nm.
910	Spare
911	Radar beam width in degrees. (Converted to one-half beam width in radians by the model.)
912	Spare
913	Probability radar is fully operable. (Used when X(2) set.)
914-916	Spares
917	Ship number of bistatic transmitter. Used only with bistatic radars. If transmitter is not located on a ship, a dummy ship must be input at the appropriate geographical location of the transmitter.
918	Bistatic transmitter antenna height in feet. Used only with bistatic radars.
919-920	Spares
921-940	Radar Class 2
.	.
.	.
.	.
1181-1200	Radar Class 15

5. Ship Position Inputs

BLUE ship positions are input by specifying the class of a ship that is at a given location. The position may be entered as the range and bearing from force center or as X and Y coordinates in nautical miles. The form must be

the same for all ships and is dependent on the value of X(78). The left and right firing bearing for the ships must also be specified if firing sectors are used. If a mix of some ships with firing sectors and others without is used, X(8) should be set to 1 and appropriate bearings entered for all ships. Ships which are not limited should be assigned a left bearing of 000 and a right bearing of 359.99. A maximum of 40 ships may be used. Ship 1 is input into X(1201) to X(1205); ship 2 in X(1206) to X(1210); etc.

X( )	Inputs
1201	Ship class number.
1202	If X(78) = 0, circle in nautical miles = 1, X coordinate in nm
1203	If X(78) = 0, bearing from forces center in degrees true = 1, Y coordinate in nm
1204	Left sector limit, degrees true, use if X(8) = 1.
1205	Right sector limit, degrees true, use if X(8)= 1. In assigning sector limits to ships with no limitations, put 000 in X(1204) and 359.99 in X(1205).
1206-1210	Ship number 2
.	.
.	.
.	.
1396-1400	Ship number 40

6. Reaction Time Distribution Function Inputs

These inputs provide appropriate delays, in minutes, for processing events during the simulation. A detailed description of the functions together with an example is contained in Appendix B under subroutine REACT. There are

seven events which may be specified by up to five different classes of delay functions for each event. The reaction functions 2, 3, 5, and 7 are related to ship class inputs. Functions 1, 4, and 6 are used with radar class inputs.

#1: Detactability to Detection (5 classes)

X( )	Inputs
1401	Delay in minutes for 0.1 cumulative probability.
1402	Delay in minutes for 0.2 cumulative probability.
1403	Delay in minutes for 0.3 cumulative probability.
1404	Delay in minutes for 0.4 cumulative probability.
1405	Delay in minutes for 0.5 cumulative probability.
1406	Delay in minutes for 0.6 cumulative probability.
1407	Delay in minutes for 0.7 cumulative probability.
1408	Delay in minutes for 0.8 cumulative probability.
1409	Delay in minutes for 0.9 cumulative probability.
1410	Delay in minutes for 1.0 cumulative probability.
1411-1420	Class 2 of RTDF1
.	.
.	.
.	.
1441-1450	Class 5 of RTDF1
#2:	Detection to ID and Designation to Weapons Direction Equipment (5 classes)
1451-1460	Class 1 of RTDF2
.	.
.	.
.	.
1491-1500	Class 5 of RTDF2

X( )	Inputs
#3:	ID and Designation to Fire Control System (FCS) Assignment (5 classes)
1501-1510	Class 1 of RTDF3
.	.
.	.
.	.
1541-1550	Class 5 of RTDF3
#4:	FCS Assigned to Acquisition (5 classes)
1551-1560	Class 1 of RTDF4
.	.
.	.
.	.
1591-1600	Class 5 of RTDF4
#5:	FCS Acquire to Fire (5 classes)
1601-1610	Class 1 of RTDF5
.	.
.	.
.	.
1641-1650	Class 5 of RTDF5
#6:	Detectability to Detection for Fire Control Radar in Horizon/Sector Scan Mode (5 classes)
1651-1660	Class 1 of RTDF6
.	.
.	.
.	.
1691-1700	Class 5 of RTDF6
#7	Decisional Delay for Horizon/Sector Scan Mode (5 classes)
1701-1710	Class 1 of RTDF7
.	.
.	.
.	.
1741-1750	Class 5 of RTDF7
1751-1800	Spares

7. Raid Class Inputs

Raid classes are used to specify the launch platforms for the RED ASM/SSM and standoff jammers. The launch platforms can be aircraft or surface units. Submarines are required to be on the surface for launch and are input as a surface unit. The raid classes contain the offensive capability of the RED units in terms of weapons carried, radar class, jamming ability, and speed. The inputs also specify the radar cross section of the raider and the number of hits to put it out of action. A maximum of 10 classes may be input. Raid class 1 is contained in X(1801) to X(1820); raid class 2 in X(1821) to X(1840); etc.

X( )	Inputs
1801	Spare
1802	Number of hits to put out of action, always 1 for aircraft. Must be whole number.
1803	Number of first type weapons carried.
1804	Class of first type weapon.
1805	Number of second type weapons carried.
1806	Class of second type of weapon.
1807	Radar class number.
1808	Salvo switch (surface and subsurface only) 0 = 1 missile per salvo 1 = 2 missiles per salvo
1809	Launch cycle time for salvo, minutes for surface/subunits only.
1810	Jamming power, w/MHz on band 1.
1811	Jamming power, w/MHz on band 2.
1812	Jamming power, w/MHz on band 3.

X( )	Inputs
1813	Jamming power, w/MHz on band 4.
1814	Raid speed, knots (converted by the model to nm/min).
1815	Raid radar cross section, meters squared.
1816	Fourth root of raid radar cross section (computed by the model).
1817	Jammer beam width in degrees. (Converted to one-half beam width in radians by the model.)
1818	Jammer side-lobe ratio. Number of db that average side-lobe is below main beam. Enter as negative number. (Converted by model to side-lobe coefficient for use in obtaining jamming effects.)
1819-1820	Spares
1821-1840	Raid Class 2
.	.
.	.
.	.
1981-2000	Raid Class 10

8. Raid Weapon Class Inputs

The raid weapon classes specify the types of ASM/SSM by their flight characteristics, reliabilities, and radar cross section. A total of 20 different classes may be used. Weapon class 1 is input in X(2001) to X(2010); weapon class 2 in X(2011) to X(2020); etc.

X( )	Inputs
2001	ASM/SSM speed, knots (converted by the model to nm/min).
2002	ASM/SSM flight altitude, ft.

X( )	Inputs
2003	Launch range[4]
2004	Reliability (launch and initial guidance).
2005	Inflight reliability (including homing and fusing).
2006	Radar cross-section, meters squared.
2007-2008	Spares
2009	Weapon horizon, nm (computed by model).
2010	Fourth root of radar cross section (computed by model).
2011-2020	Weapon Class 2
.	.
.	.
.	.
2192-2200	Weapon Class 20

9. Raid Position Inputs

These inputs contain the location, course, and altitude of an individual launch platform. If the raider has a jammer, the jammer target is also specified. A maximum of 90 raiders is permitted. Raid 1 is input in X(2201) to X(2206); raid 2 in X(2207) to X(2212); etc.

X( )	Inputs
2201	Raid class number (1, 2, etc.)
2202	Range, nm (from (0,0)).
2203	Bearing, degrees true (from (0,0)).

---

[4] Launch Range is measured from the position (0,0). The user must consider this fact when dealing with dispersed formations and multiple target list. The distance of the intended launch point from force center is the proper input, not the range of the launch point from the primary target.

X( )	Inputs
2204	Altitude, feet (less than 50 feet for surface/subsurface units).
2205	Course, degrees true.
2206	Jammer's jamming target: 0 = no jam capability N = ship number of jamming target 999 = force center (0,0)
2207-2212	Raid number 2
.	.
.	.
.	.
2734-2740	Raid number 90

B. THE TARGET LIST ASSIGNMENTS

The target list assignments are read in immediately following the zero card indicating the end of the X vector inputs. Each RED raider must be assigned a target list, even if the raider carries no weapons. If the raider carries no weapons the target list information is not used, but the input logic requires that some number be entered. There must be a total of three cards which are to be dimensioned 30I2. The first thirty raiders are entered with card one, the second thirty raiders on two, etc. For example, if the simulation has four RED aircraft, column 2 card 1 would contain the number of the target list for raider number 1; column 4 card 1 that for aircraft number 2; etc. Columns 9 through 60 on the first card, and 1 through 60 on the next two cards could contain any integers desired, usually 00.

C. THE TARGET LISTS

The cards that input the target lists follow immediately after the three cards described above. The values to be read in are stored in the array PLIST. This is a (40,6) array in which the columns are the target lists. The array allows for up to 40 individual targets and six separate listings of targets. The target list is identified by its column number, and it is this number that was entered in NRTGT. The PLIST cards follow immediately after the three input cards for NRTGT mentioned above. The format for the PLIST cards is 10F8.4. The column entries are the total probability of targeting all ships up to and including the target ship in the given row. As an example, in the case of three target lists and five BLUE ships the PLIST array could appear as follows:

	1	2	3	4	5	6
1	.12	0.0	.25	0	0	0
2	.42	.25	.50	0	0	0
3	.62	.50	.50	0	0	0
4	.82	.75	1.0	0	0	0
5	1.0	1.0	1.0	0	0	0
6	0	0	0	0	0	0

The raiders that have been assigned target list 1 would have a probability of .12 of firing a missile at ship 1 each time it fires. It would have a probability of .3 of firing at ship 2, and .20 of firing at ship 3. A raider firing a missile with target list 2 would have a probability of 0.0 of firing at ship 1 and .25 of firing at any of the other four. A raider with list 3 would have a .25 probability of

firing at ship 1, a .25 probability of firing at ship 2, and a .50 probability of firing at ship 4.

The input cards for the PLIST array would be structured as follows. Card one would contain .12 in columns 1-8, .42 in 9-16, .62 in 17-24, .82 in 25-32, 1.0 in 33-40, and zeros throughout the remainder. Cards two, three, and four would contain zeros. Since card five starts list two, it is filled out in the same manner as card one, with, in this case, cards 6, 7, and 8 containing zeros. Since there are only five ships and three lists, the last card required for this run would be card 9. If the full 40 ships and six target lists were being used, a total of twenty-four cards would be required to input the target lists.

V. MODEL OUTPUT

The model produces three types of output. The types are standard, special displays, and debugging. For debugging, there are a number of switches in the control section of the inputs which may be set to provide intermediary values during the iteration. The special displays provide one time outputs of geographical plots, histograms, and selected tables. The standard output occurs at the end of each iteration and contains an abbreviated battle history along with statistical data concerning the engagement.

A. STANDARD OUTPUT

The standard output consists of the ASM table, the SAM-ASM-RAID table, and statistics regarding hits, detections, and opportunities to engage. The contents of the tables are given below. The actual format of this output is provided in the tables of representative output at the end of this section.

1. The ASM Table

Column 1	ASM/SSM number. This number identifies the ASM/SSM by target number. The order in which the missiles were launched or destroyed can be determined by subtracting 90 from the target number.
Column 2	Status code. This code indicates the disposition of the missile. The code is as follows: 0 missile failed on launch. 1 missile was in flight.

2 missile was destroyed by SAM. The SAM-ASM-RAID table will indicate which missile ship was responsible.

3 missile failed in flight.

4 missile flight successful, missile impacted on target ship.

5 missile destroyed when raider destroyed.

Column 3	Time of impact. This will be the time the missile impacted, or would have impacted, unless it was lost when raider was destroyed. In this case it will be 0.0.
Column 4	Launch raid.
Column 5	Target ship. Target ship number unless the missile was lost with raider destruction.
Column 6	Launch time. The time of missile launch unless lost when raider destroyed. In this case it is the time of loss.
Column 7	Weapon class. If lost with raid, 0.0.
Column 8	X coordinate at launch.
Column 9	Y coordinate at launch.

2. <u>The SAM-ASM-RAID Table</u>

Column 1	Target number. Targets 1 through 90 are raiders, 91 through 190 are missiles.
Column 2	Launcher. The launcher code AAB, where AA is the ship number and B is the launcher.
Column 3	Channel. The director-channel code AB where A is the director number and B is the channel number.
Column 4	Time of Launch. Time of BLUE missile launch.
Column 5	Kill code. The code is as follows: a negative number, an overkill, the number indicating the number of missiles in the salvo; a zero, a missile failure or system support failure; a positive number, a kill, the value indicating the number of missiles in the salvo.

Column 6 Time channel free. The game time that this launcher-channel combination will be available for re-engagement or reassignment.

3. Statistical Output

The output form of the statistics for each iteration are underlined. The definitions of the terms used follow each form.

The ships took "H" hits: The total number of hits (H) sustained by the BLUE force.

Of "X" ASMs fired, "Y" ("Z" percent) failed at launch.

X: total number of ASM/SSM that survived to launch.

Y: of X, the number that failed on launch.

Z: Y/X.

Of launched ASM, "W" ("P" percent) were killed by SAMs, "Q" ("R" percent) failed in flight.

Launched ASM; from above, X-Y.

W: the number of RED SSM/ASM shot down.

P: W/Launched ASM.

Q: the number of RED SSM/ASM that failed in flight.

R: Q/Launched ASM.

Of total ASMs available "I" ("J" percent) were destroyed when mother killed by SAMs.

Total ASMs: All SSM/ASM carried by engageable raiders or raiders that reach a launch position.

I: The number of RED ASM/SSM lost when raider destroyed.

J: I/Total available.

"D" SAMs were launched of which "E" ("F" percent) failed and "G" ("H" percent) were overkills.

D: Total BLUE SSM/SAM launched.

E: Number of SAM/SSM evaluated as failure at intercept or system support.

F: E/D.

G: Overkills. Overkill occurs when the target does not survive to the SAM intercept point due to being shot down. If the target is a missile and the RED missile reaches its target prior to intercept, this intercept is scored as a failure and not an overkill.

H: G/D.

The ship statistics for each iteration are printed in a table labeled SHIP STATS. The format is as follows:

Column 1	Ship number.
Column 2	Chances to engage. The number of RED targets that will enter this ship's missile envelope.
Column 3	Number of engagements. The number of actual missile intercept evaluations.
Column 4	Number of targets killed.
Column 5	Bombers detectable. Of those targets that will enter the ship's missile envelope, the number that are raiders.
Column 6	Bombers detected. Of the raiders detectable, those detected.
Column 7	ASM's detectable. Those ASM/SSM that will enter the ship's missile envelope.
Column 8	ASM's detected.

The following additional statistics are provided with the SHIP STATS table:

Average detection range: The average detection range of each ship on those targets that entered its missile envelope.

"X" ASMs were fired on by the fleet. X is the number of ASM/SSM that were engaged by one or more BLUE units.

"X" Bombers were fired on by the fleet. X is the number of RED raiders that were engaged by one or more BLUE units.

ASMs fired at. The number of ASM/SSM that were first engaged by each ship.

Bombers fired at. The number of RED raiders that were first engaged by each ship.

A table of the frequency of hits received by ships is printed at the end of the run. This table displays a distribution of the hit frequency over all ships for all runs. It constitutes a histogram of hit frequencies for all BLUE units.

B. SPECIAL DISPLAY SWITCHES

The below listed switches will provide the indicated output if set to one or the specified value. Setting X(2) to 1 will provide the equipment availability status for each iteration. The remaining switches provide a one-time output for a run.

X(2)	Indicates equipment availability check desired. Prints out each ship number and equipment status.
X(24)	Plot of BLUE unit positions using DISPL if set to 1. Plot of raider tracks and launch points using RAIDIS if set to 2. Both plots are provided if set to 3.
X(51)	Prints the SHIP table at the end of the first iteration. The table is structured as follows: (see Table IV)

Column 1 Ship number.

Column 2	Ship class number.
Column 3	Ship's X coordinate.
Column 4	Ship's Y coordinate.
Column 5	Hits to sink. The number of RED SSM/ASM missile hits to put out of action.
Column 6	Class address. The ship class starting index in the X array.
Column 7	Up/down. 0 = sunk 1 = operating normally.

X(52) Prints the RAID table at the end of the first iteration in the following form: (see Table IV)

Column 1	RAIDER	The raid number, 1-90.
Column 2	CLASS	The class starting index in the X array.
Column 3	TIMER (R)	The time the raider was at the position indicated in columns 4 and 5.
Column 4	XR	The raider's X position at the time specified in column 3.
Column 5	YR	The raider's Y position at the time specified in column 3.
Column 6	XEOG	The X position of the raider at the time specified as the end of the game.
Column 7	YEOG	The Y position at the end of the game.
Column 8	XL	The raider X position at its first launch time. If the raider has no missiles, or cannot reach a launch position, the end of game position will also be indicated here.
Column 9	YL	The raider Y position at first launch.

Column 10	ALT	The raider altitude in feet. If 50 feet or below, the raider is considered a surface or subsurface unit.
Column 11	HORZ	The raider radar horizon in miles.
Column 12	WEP-CLASS	The class number of the raider's longest range ASM/SSM.
Column 13	WEPS	The total number of weapons carried by the raider.
Column 14	UP/DOWN	The status of the raider at the end of the game. 0 = shot down or sunk 1 = operating normally.

X(53) Prints the SAM table at the end of the first iteration. The table is organized as follows: (see Table V)

Column 1	SAM	The salvo number.
Column 2	SAM CLASS INDEX	The SAM type class number for the SAM/SSM in this BLUE miss-le salvo.
Column 3	SHIP NUMBER	The firing ship.
Column 4	SAM LEFT	The number of SAM/SSM remaining in the battery's magazine after this salvo was fired.
Column 5	CH1 FREE	This is the time that channel 1 for the fire control radar used in this intercept will be free for reengagement or reassignment. If the missile requires director illumination throughout missile flight, or the missile is totally independent of the director, this is an indication of system availability.

Columns 6-10	Channel availability times for systems employing a time sharing system of homing.
Column 11 SALVO	The number of missiles in the salvo.

X(85) If the number of iterations is between 10 and 100, prints a histogram of hit frequency and ASM/SSM arrival interval for the BLUE ship who's number has been entered.

C. THE DEBUGGING SWITCHES

The debugging switches, X-3,9,12,15,54,55,56,57,58,59, 60, are set by assigning a value of 1 to the specified location in the X-array. These switches are subroutine related and will provide the indicated output whenever the program cycles through the appropriate portion of the subroutine. Reference should be made to the description of the subroutines in Appendix B when using the debugging switches.

In the below format, the debug switch which must be set to 1 is listed and is followed by the subroutine name with its associated output. The output is in the form as it appears in the computer printout. The parenthesis indicate the location of the intermediary values.

X-3

SUBE1	Detection range by ship ( ) on raider ( ) with radar ( ) in clear, jamming, and horizon limited environments.
	Reaction time delays for raid ( ) by ship ( ).
	Bistatic radar gain and lose contact times on raider ( ) by ship ( ).

SUBE2	ASM/SSM failed on launch.
	Detection range by ship ( ) on ASM/SSM ( ) with search radar ( ) in clear, jamming, and horizon limited environments.
	No detection due to reaction time delay.
	Detection range on ASM/SSM by ship ( ) on missile ( ) with system ( ) fire control radar ( ) in clear, jamming, and horizon limited cases. Jamming range of 999. indicates no jamming.
	Earliest search radar detection time and earliest fire control radar detection time ( ) ( ).
	When missile launch time will exceed the launch interval set by the user, the launch does not take place. Output is: bomber ( ) could not fire as launch time was ( ) and all ASM's had to be launched by ( ).

X-9

SUBE3	EV 3 Ship ( ) target ( ) reason ( ).
	EV 3 SAM ( ) battery ( ) channel ( ).
PRIOR	PRIOR debug data input channel ( ) output channel ( ) battery number ( ) input target ( ) output target ( ).
TIMMY	Intercept data: target, firing ship, firing ship position, intercept position, number of firing zones, left and right bearings of the firing zones, launch bearing of SAM.
	Target, firing ship, indicator flag, reason.

X-12

MAIN	Original X array as read into the computer.
	The target lists as read into the computer.
	The target list assignments as read into the computer.

X-15		
	MAIN	The X-array as converted by the program.
X-54		
	MAIN	Prints out all random numbers used in the first iteration, in the order they were used.
X-55		Provides the computer time that the program enters and leaves the specified subroutine.
	EFFECT	Login, logout
	JULIE	Login, logout
	EVENT	Login, logout
	GETEV	Login, logout
	STOREV	Login, logout
	REMOVE	Login, logout
	TMDASM	Login, logout
	TMDBOM	Login, logout
	SUBE1	Login, logout
	SUBE2	Login, logout
	SUBE3	Login, logout
	SUBE4	Login, logout
	SUBE5	Login, logout
	SUBE6	Login, logout
	LOCTIM	Login, logout
	PRIOR	Login, logout
	TIMMY	Login, logout
	RCHECK	Login, logout
	JAMM	Login, logout
	BIDET	Login, logout

X-56

SUBE4	EV 4 ASM ( ) ship ( ) ASM status ( ) hits on ship ( ) time ( ).
SUBE5	EV 5 target number ( ) firing ship ( ) launcher ( ) salvo number ( ) time ( ).

X-57

SUBE1	Detection ranges by ship ( ) on raider ( ) with system ( ) fire control radar ( ) in clear, jamming, and horizon limited cases. Raider ( ) surface or submarine unit, ship ( ) has no SSM. Detection ranges on raider ( ) by ship ( ) in horizon search mode.
SUBE2	Reaction time delays. Detection ranges in horizon search mode of ASM/SSM ( ) by ship ( ) in clear, jamming, and horizon limited cases.
TMDASM	No engagement possible, raid ( ) target skip ( ) battery ( ) missile ship ( ) ASM/SSM ( ). No engagement possible; raider ( ) ship ( ). Engagement data - time entering and time leaving a given range from ship ( ).

X-58

JULIE	Number of SAM/SSM in each battery.
SUBE2	Prints the NONO table after each raider's launch cycle. NONO table codes are contained in the description of SUBE2 in Appendix B.
SUBE5	For salvo ( ) results ( ).

X-59

TIMMY	Crossing target data: target, firing ship, angle between target flight path and line of sight at launch, angle between SAM/SSM flight path and target flight path, angle between SAM/SSM flight path and line of sight at launch, target position at launch, GSINE, range to target at launch.

X-60

JULIE	The events list at start of the iteration.
EVENT	The event retrieved.
STOREV	The event stored.
	The event lost.

```
THE NUMBER OF SAMS LEFT AT THE END OF ITERATION 1 WAS 126

                                   ASM TABLE
                                  ITERATION 1
  ASM      STATUS    TIME OF    LAUNCH    TARGET    LAUNCH    WEAPON      X         Y
 NUMBER     CODE     IMPACT      RAID      SHIP      TIME     CLASS     LAUNCH    LAUNCH
   91        5.        0.0        2.        0.       15.36     0.         0.0       0.0
   92        5.        0.0        2.        0.       15.36     0.         0.0       0.0
   93        5.        0.0        2.        0.       15.36     0.         0.0       0.0
   94        5.        0.0        2.        0.       15.36     0.         0.0       0.0
   95        5.        0.0        1.        0.       16.37     0.         0.0       0.0
   96        5.        0.0        1.        0.       16.37     0.         0.0       0.0
   97        5.        0.0        1.        0.       16.37     0.         0.0       0.0
   98        5.        0.0        1.        0.       16.37     0.         0.0       0.0
   99        5.        0.0        5.        0.       17.13     0.         0.0       0.0
  100        5.        0.0        5.        0.       17.13     0.         0.0       0.0
  101        5.        0.0        5.        0.       17.13     0.         0.0       0.0
  102        5.        0.0        5.        0.       17.13     0.         0.0       0.0
  103        2.      26.694       3.        1.       20.46     1.        11.58    -99.33
  104        0.      27.542       3.        1.       21.86     1.       - 2.59    -91.15
  105        2.      27.706       3.        1.       22.11     1.       - 5.11    -89.69
  106        2.      28.392       3.        1.       23.07     1.       -14.91    -84.04
THE ORIGINAL ATTACK CONSISTED OF 5 RAIDERS.  1 WERE LEFT AFTER THE ATTACK.
```

TABLE I

REPRESENTATIVE OUTPUT FOR ASM TABLE

```
                              SAM-ASM-RAID TABLE
TGT NO.     LAUNCHER     CHANNEL     TIME OF LAUNCH     KILL CODE     TIME CHANNEL FREE
   2.          21.          17.           10.61              1.               15.36
   1.          21.          17.           12.15              1.               16.37
   5.          31.          17.           12.37              1.               17.13
   3.          51.          17.           13.90              0.               18.15
   3.          41.          17.           18.15              0.               21.61
 103.          41.          17.           21.09              1.               22.85
   3.          41.          17.           21.61              1.               23.92
 105.          41.          17.           22.76              1.               24.69
 106.          41.          17.           23.18              0.               25.49
 106.          21.          17.           25.49              1.               27.03
STATISTICS FOR ITERATION NO. 1
    THE SHIPS TOOK  0 HITS.
    OF  4 ASMS FIRED, 1 (25.00 PERCENT) FAILED AT LAUNCH,
    OF LAUNCHED ASM, 3 (100.00 PERCENT) WERE KILLED BY SAMS,
                     0 (0.0 PERCENT) FAILED IN FLIGHT.
    OF THE TOTAL ASMS AVAIL,  12 (75.00 PERCENT) WERE DESTROYED WHEN
                                         MOTHER KILLED BY SAMS.
    10 SAMS WERE LAUNCHED OF WHICH  3 (30.00 PERCENT) FAILED AND
                                    0 ( 0.0  PERCENT) WERE OVERKILLS.
    334 RANDOM NUMBERS WERE DRAWN.
SUMMARY FOR 1 ITERATIONS
    OF 4 ASMS FIRED, 1  (25.00 PERCENT) FAILED AT LAUNCH,
    OF LAUNCHED ASM, 3 (100.00 PERCENT) WERE KILLED BY SAMS,
                     0 (  0.0  PERCENT) FAILED IN FLIGHT.
    OF THE TOTAL ASMS AVAIL,  12 (75.00 PERCENT) WERE DESTROYED WHEN
                                         MOTHER KILLED BY SAMS.
    AVERAGE NUMBER OF HITS ON FLEET FOR 1 ITERATIONS IS 0.0
    10 SAMS WERE LAUNCHED OF WHICH  3 (30.00 PERCENT) FAILED AND
                                    0 ( 0.0  PERCENT) WERE OVERKILLS.
```

TABLE II

REPRESENTATIVE OUTPUT FOR SAM-ASM-RAID TABLE AND THE STATISTICS

```
334 RANDOM NUMBERS WERE DRAWN.
                              SHIP STATS FOR ITERATION 1
SHIP   CHANCES     NUMBER OF    TARGETS   BOMBERS      BOMBERS     ASMS          ASMS
 NO.  TO ENGAGE   ENGAGEMENTS   KILLED   DETECTABLE   DETECTED   DETECTABLE   DETECTED

 1        4            0           0         1            1           3            3
 2        6            3           3         3            3           3            3
 3        8            1           1         5            5           3            3
 4        7            5           3         4            4           3            3
 5        7            1           0         4            4           3            3
SHIP       AVE DET RANGE        AVE DET RANGE
              BOMBERS               ASMS

 1            142.96                69.38
 2             86.26                61.68
 3             63.20                23.85
 4             77.66                49.21
 5             67.44                16.02
   3 ASMS WERE FIRED ON BY THE FLEET
   4 BOMBERS WERE FIRED ON BY THE FLEET
SHIP       ASMS FIRED AT        BOMBERS FIRED AT
 1              0                    0
 2              0                    2
 3              0                    1
 4              3                    0
 5              0                    1
   HITS ON SHIP "I"
  1   0
  2   0
  3   0
  4   0
  5   0
```

TABLE III

REPRESENTATIVE OUTPUT FOR SHIP STATS TABLE

```
                            SHIP TABLE

SHIP    CALSS      X          Y       HITS TO SINK    CLA-ADR    UP/DOWN

  1      1.       0.0        0.0          5.           101.        1.
  2      2.      25.00      25.00         1.           141.        1.
  3      2.     -25.00      25.00         1.           141.        1.
  4      2.     -25.00     -25.00         1.           141.        1.
  5      2.      25.00     -25.00         1.           141.        1.


                            RAID TABLE

RAIDER      CLASS    TIMER(R)      XR         YR        XEOG       YEOG

  1         1801.     15.34       15.7       120.9      122.5    -1100.6
  2         1801.     14.86       71.3       118.3     -950.0    - 570.6
  3         1801.     21.61       32.0      - 67.2     -998.4      483.8
  4         1801.     26.17      -51.5       122.1      498.2     1074.2
  5         1801.     16.33      -99.3       104.0      774.5    - 739.8

  XL          YL       ALT        HORZ      WEP-CLASS     WEPS    UP/DOWN

  17.6        98.4    10000.0     174.         1.          4.        0.
  34.9        93.7    25306.0     196.         1.          4.        0.
  11.6       -99.3    35000.0     230.         1.          4.        0.
 498.2      1074.2    10000.0     123.         1.          4.        1.
 -67.7        73.6    27000.0     202.         1.          4.        0.
```

TABLE IV

REPRESENTATIVE OUTPUT FOR SHIP AND RAID TABLES

```
                         SAM TABLE

SAM    SAM CLASS INDEX    SHIP NUMBER    SAM LEFT    CH1 FREE

 1           1.               2.            29.        15.36
 2           1.               2.            28.        16.37
 3           1.               3.            29.        17.13
 4           1.               5.            29.        18.15
 5           1.               4.            29.        21.61
 6           1.               4.            28.        22.85
 7           1.               4.            27.        23.92
 8           1.               4.            26.        24.69
 9           1.               4.            25.        25.49
10           1.               2.            27.        27.03

CH2 FR    CH3 FR    CH4 FR    CH5 FR    CH6 FR    SALVO

  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
  0.0       0.0       0.0       0.0       0.0       1.
```

TABLE V

REPRESENTATIVE OUTPUT FOR SAM TABLE

VI. CONCLUSIONS

The use of bistatic search radars is not a new concept. FADS provides a method of evaluating their potential usefulness to the Navy. As demonstrated in the sample problem, FADS also has many applications in weapons systems analysis and the analysis of tactics.

The model was structured along the lines of the FLOATS model in use at the Johns Hopkins University Applied Physics Laboratory. The additional capabilities introduced by FADS should provide a basis for a more realistic view of the present day and future tactical environments. The employment of decoys, dispersed formations, and passive missile traps are but a few of the ways in which FADS might be utilized.

Lastly, the model is ideal for use in an advanced war gaming course. The model is complex, but the simulation was written with ease of reading in mind. With rewriting the core requirements might be reduced, but, in its present form, FADS is easily read and understood, and it could be disected by the interested student with ease.

APPENDIX A

BISTATIC RADAR SYSTEMS

Although the bistatic radar system was described in the introduction as a radar system in which the transmitter and the receiver are not collocated it is necessary to point out that the separation between the transmitter and the receiver should be comparable to the target distance, that is, on the order of several nautical miles as opposed to several feet. The assumed bistatic system is to provide detection and location information similar to that obtained with current search radar systems. It should in essence provide the user with what would be on a plan position indicator (PPI) scope. No provision is assumed for height finding capability. The basic difference between the target geometry for monostatic and the bistatic radar systems is shown in figure A1.

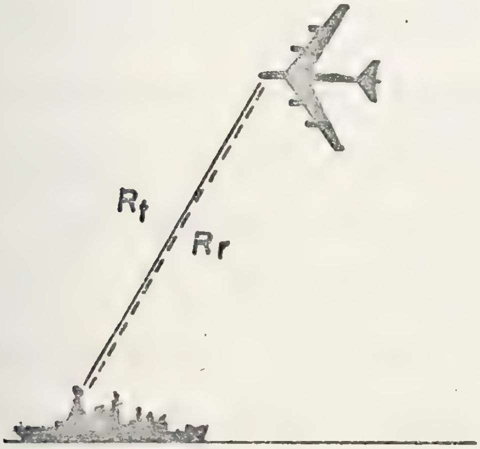


Figure A1a
Monostatic Radar Principle

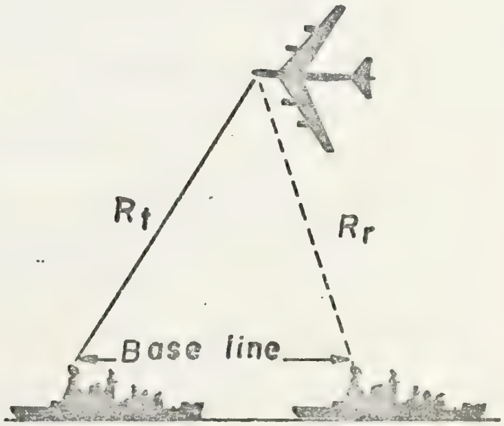


Figure A1b
Bistatic Radar Principle

The bistatic radar concept is not a recent development, although the technology required to bring the system up to the capabilities described above is. The bistatic concept predates the monostatic radar in that the development of the radar duplexer was required in order to convert the original bistatic radar to a monostatic system. Sholnik [Ref. 10, p. 585] states:

> Its (the bistatic radar) principle was known and demonstrated many years before the development of practical monostatic radar. ...the first "radar" observations in both the United States and in Great Britain were made with separated CW transmitters and receivers. These early radars were known as wave-interference equipment but were the same as what would now be called bistatic radar. Taylor and Young of the Naval Research Laboratory first demonstrated bistatic radar for the detection of ships in 1922. Their work was disclosed in a patent issued in 1934. The early experiments with wave-interference (bistatic) radar led to the development of monostatic radar in the late 1930s in both this country and abroad. Further development was put aside after the demonstration of the more versatile monostatic-radar principle. Bistatic radar lay dormant for about fifteen years until it was "reinvented" in the early 1950s and received new interest.

Current interest is conceivably motivated by considerations of electromagnetic counter-measures, defense against anti-radiation missiles, and deception roles.

One method for target location with a bistatic system requires knowledge of the distance from the transmitter to the target, (R_x), and to the receiver (R_r), the horizontal angle between the base line (a line from the receiver to the transmitter) and the target bearing, and the elevation angle from the receiver to the target. However, in the simulation problem it is not necessary to determine a target's

location since the target's position at any time is a function of the input parameters. It is only necessary to determine if the target is detectable and, given that it is, determine where along the target's track an individual radar is able to detect the target.

Detection occurs when the reflected power at the receiver is greater than the detection threshold of the receiver for a given probability of detection. The radar range equation for the bistatic radar is identical to the well known monostatic range equation except that the power received varies inversely with the product of $R_x^2 R_r^2$. Additionally the two-way propagation losses differ since the path of the reflected signal is not the same as that of the transmitted signal. The range equation can be readily written in terms of the constants for the radar system, the variables R_x, R_r and the target's radar cross section.

For comparison purposes both the monostatic and the bistatic detection range equations are given below:

$$\text{Monostatic} \quad P_r = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 L_p^2 L_s R^4}$$

$$\text{Bistatic} \quad P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 L_p(t) L_p(r) L_s R_r^2 R_x^2}$$

where:

R = range to target (monostatic)

R_x = range from transmitter to target (bistatic)

R_r = range from receiver to target (bistatic)

P_t = power of transmitter

P_r = power received at the receiver

G = gain of monostatic antenna

G_t = gain of bistatic transmitter antenna

G_r = gain of bistatic receiver antenna

λ = radar wavelength

σ = target's radar cross section (see below for discussion of bistatic and monostatic approximation)

L_p = one way propagation losses for monostatic

$L_p(t)$ = propagation losses from transmitter to target (bistatic)

$L_p(r)$ = propagation losses from target to receiver (bistatic)

L_s = system losses

By defining P_r as the minimum power required by the receiver in order to obtain a given probability of detection with typical propagation and system losses and by grouping constants of the radar system, the above equations can be simplified to read: $R = \beta\sigma^{\frac{1}{4}}$ and $R_x^2 R_r^2 = \beta^4\sigma$ where β is the range at which a particular radar system can detect a one square meter target in a non-jamming environment. Values of β for current U.S. Navy radars are listed in Ref. 9.

When standoff electronic noise jamming is present, the range equations are defined in a similar manner:

$$\text{Monostatic:} \quad R_{bt}^4 = \frac{P_t G\,\sigma}{4\pi B_r (S/J)\Sigma JP}$$

$$\text{Bistatic:} \quad R_{bt}^2 R_x^2 = \frac{P_t G_t^{\frac{1}{2}} G_r^{\frac{1}{2}}\,\sigma}{4\pi B_r (S/J)\Sigma JP}$$

where:

R_{bt} = burn through range monostatic

B_r = receiver band width

S/J = signal-to-jamming ratio (includes propagation losses)

ΣJP = sum of jamming power arriving at the receiver

The jamming level from an individual jammer is obtained by multiplying the power of the jammer by the appropriate coefficient for the geometry of the radar and jammer main to side-lobe ratios and dividing by the square of the distances between the jammer and the radar. The individual jamming levels are then added to obtain the sum of the jamming power arriving at the radar.

As in the case with the non-jamming environment, the above equations can be simplified by defining a term α which contains the constants of the radar system and which is equal to the range at which a one square meter target can be detected in the presence of one watt of jamming power per megahertz. The monostatic range equation in jamming is:

$$R_{bt} = \alpha^{\frac{1}{2}}(\sigma/\Sigma JP)^{\frac{1}{4}}$$

and the bistatic equation is

$$R_x R_r = \alpha(\sigma/\Sigma JP)^{\frac{1}{2}} .$$

In solving the bistatic detection problem in the simulation algorithm, R_x and R_r have only the target's position in common. It is therefore necessary to state the product $R_x R_r$ as a function of the target's position and solve the

detection equation in terms of the time at which the target can be detected. If a constant CHAR is defined to be the product of β^4 times σ for a clear environment and α^2 times σ divided by the sum of the jamming power for the jamming situation, the detection equation then becomes $R_x^2 R_r^2 = \text{CHAR}$. The radar is able to detect a target whenever the range product squared is less than or equal to the constant CHAR. By expressing R_x and R_r in terms of time, the solution of the bistatic equation $R_x^2(t)R_r^2(t) - \text{CHAR} = 0$ provides the times at which detection can occur and then be lost as the target moves along its track relative to the transmitter and the receiver. The below figure is a layout of the track and detection points that is illustrative of the detection equation:

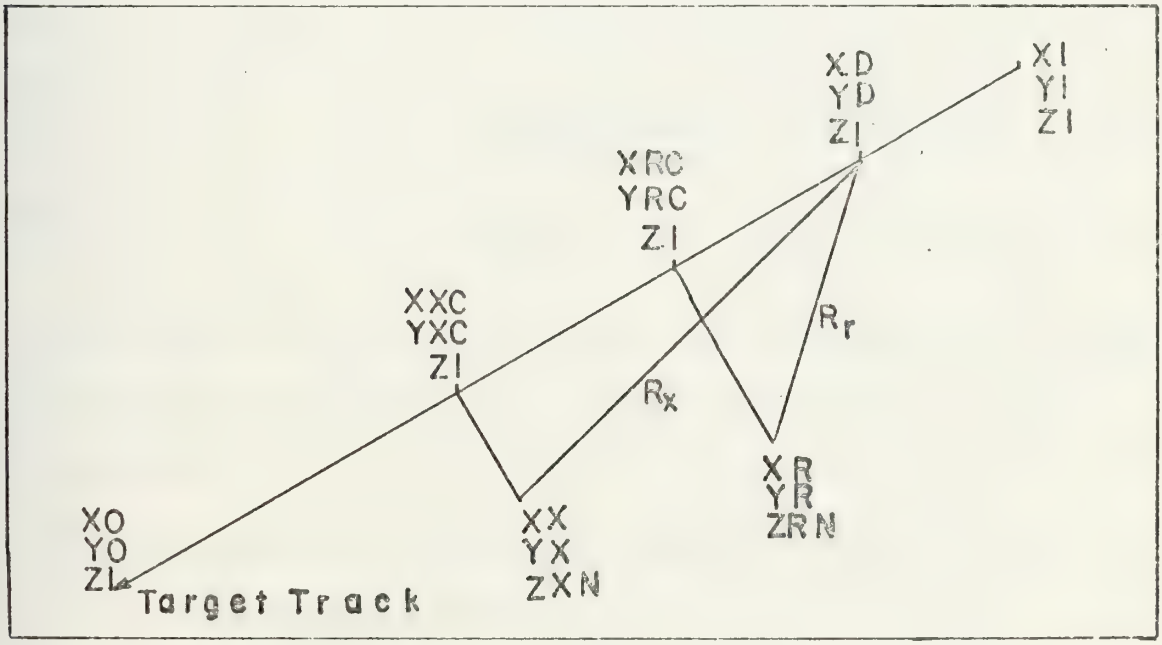


Figure A2
Bistatic Detection Geometry

Labels are as follows:

Receiver	Transmitter	Value
XR	XX	X Coord of position
YR	YX	Y Coord of position
ZRN	ZXN	antenna height in nautical miles
XRC	XXC	X Coord of track CPA
YRC	YXC	Y Coord of track CPA
CPR	CPX	Distance to CPA
Track		
X1,Y1		initial position
Z1		altitude in nautical miles
XO,YO		terminal position
V		velocity in nm/min
Vx		velocity in X direction
Vy		velocity in Y direction
XD		X Coord of detection position = (X1+VxT) where T is the time of detection
YD		Y Coord of detection position = (Y1+VyT)

The equation $R_x^2(t)R_r^2(t) - \mathrm{CHAR} = 0$ is expressed in terms of the stated positions; time is the independent variable. For example:

$$\begin{aligned} R_r^2(t) &= (XR-XRC)^2+(YR-YRC)^2+(ZRN-Z1)^2+(XRC-(X1+VxT))^2 \\ &\quad +(YRC-(Y1+VyT))^2 \\ &= (Vx^2+Vy^2)T^2-2(Vx(XRC-X1)+Vy(YRC-Y1))T+(CPR)^2 \\ &\quad +(XRC-X1)^2+(YRC-Y1)^2 \\ &= AT^2+DT+E \end{aligned}$$

In a similar manner $R_x^2(t) = AT^2+BT+C$ where $B = -2(Vx(XXC-X1)+Vy(YXC-Y1))T$ and $C = (CPX)^2+(XXC-X1)^2+(YXC-Y1)^2$.

The range equation in terms of t then reduces to

$$T^4+(\frac{B+D}{A})T^3+(\frac{C+E}{A}+\frac{BD}{A^2})T^2+(\frac{BE+CD}{A^2})T+\frac{CE - CHAR}{A^2} = 0$$

The real roots of this fourth order polynomial in ascending order are the times at which the target is first detectable, lost, redetected and then lost again. In the case where there are no real roots, the target is not detectable along its track. If only one pair of real roots exists, the radar has only one detection zone against the target.

The multiple detection zones occur when the target penetrates the contour of the equation $R_x R_r = CHAR^{\frac{1}{2}}$ in more than two locations. These contours plot as ovals of Cassini in the plane containing the base line between the transmitter and the receiver. The contours, shown in Figure A3, represent curves of constant sensitivity for the bistatic radar system and a given target. In the case of low sensitivity, the curves consist of two disjunct ellipses with the transmitter and receiver at the furthest foci. As sensitivity is increased the curves become ovals about the receiver and the transmitter and eventually become an ellipse with the transmitter and receiver at the foci. If this ellipse is rotated about its major axis, a prolate spheroid is generated which defines the detection surface for the bistatic radar.

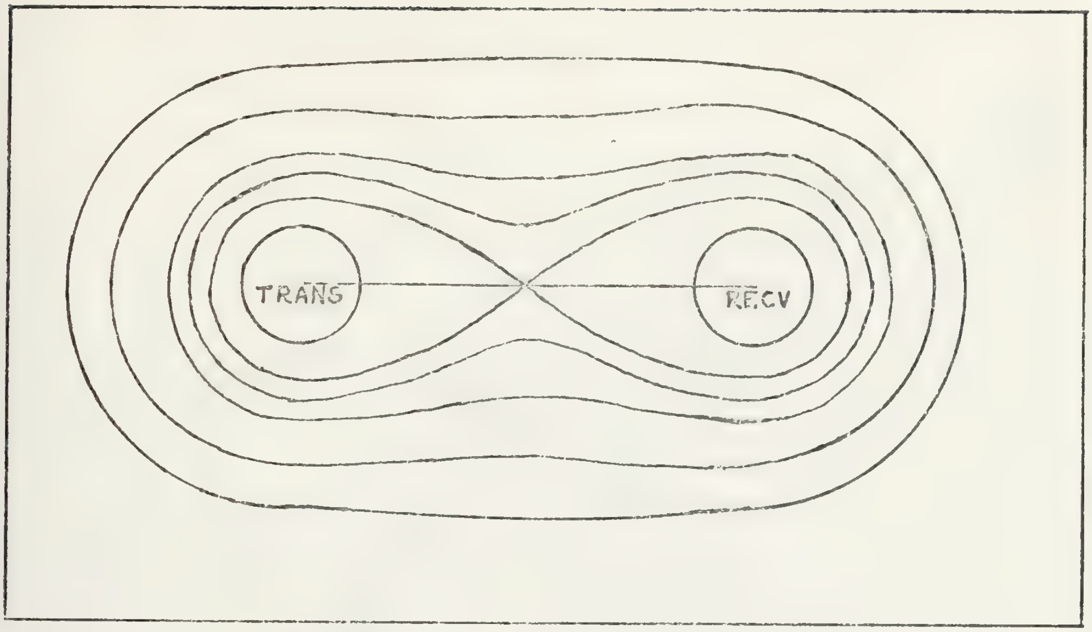


Figure A3
Curves of Constant Sensitivity for Bistatic Radar System

In addition to the requirement that a solution to the radar range equation exists, the target must also be above both the transmitter and the receiver radar horizon for a detection to occur. The radar horizon restrictions can be seen in figure A4, which uses the same track as presented in figure A2, along with an additional axis representing the aircraft position with respect to time.

The positions in figure A4 are defined in figure A2. HORX and HORR are the distances to the transmitter and receiver radar horizons for their respective antenna heights and the target's altitude. TR1 is the time the target first enters the radar horizon of the receiver; TR2 is the time it departs. TX1 and TX2 are similar times for the transmitter. The time that the target is simultaneously above both horizons is the interval (T_1^0, T_2^0) where T_1^0 = max (TR1,TX1) and T_2^0 = min (TR2,TX2).

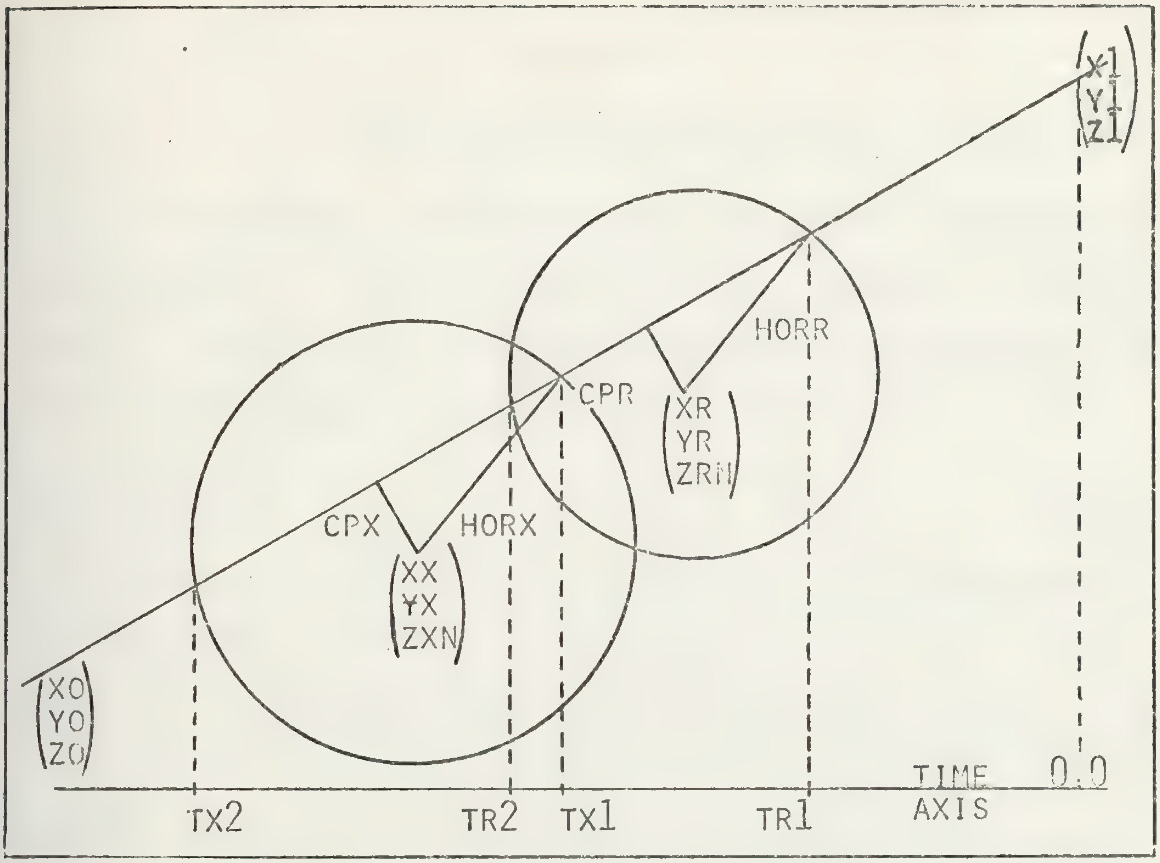


Figure A4
Intersection of the Bistatic Radar Horizons

The intersection of the joint horizon time interval (T_1^0, T_2^0) with the time intervals obtained from the range detection equation provides the time of detection and the time of lost detection for a target.

These times, in conjunction with the ranges which are related to the times, are then used in the simulation to determine "shoot events" for the defensive forces and to accumulate statistics on the detection ranges.

APPENDIX B

DESCRIPTION OF THE PROGRAM

This appendix provides a description of the FADS computer program. The MAIN portion of the program is presented first. The principal subroutines follow with the minor subroutines and functions covered last.

1. OVERVIEW

This paragraph gives an overview of the functions of the individual sections of the program.

MAIN - The MAIN program reads in the input values, compiles statistics and controls the simulation through the specified number of iterations.

EFFECT - Subroutine EFFECT controls the individual iteration by selecting the proper subroutine to play the next event in the events list.

JULIE - Subroutine JULIE initializes or resets values for each iteration.

EVENT - Subroutine EVENT controls the input and retrieval of events from the events list.

REMOVE - Subroutine REMOVE retrieves higher priority targets from the events list.

TARGET - Subroutine TARGET returns all of the "shoot" events which occur at a specified time.

SUBE1 - Subroutine SUBE1 computes detections of the raiders by the BLUE forces and determines "shoot" events against the raiders.

SUBE2 - Subroutine SUBE2 computes the RED ASM/SSM launches and subsequent detections followed by the "shoot" events against the ASM/SSMs.

SUBE3 - Subroutine SUBE3 evaluates the engageability of a target based on the situation at the proposed BLUE missile launch time.

SUBE4 - Subroutine SUBE4 determines ASM/SSM impacts on BLUE ships and evaluates out of action status for them.

SUBE5 - Subroutine SUBE5 evaluates the BLUE missile intercepts.

SUBE6 - Subroutine SUBE6 releases the fire control radar at the time of intercept.

TIMMY - Subroutine TIMMY computes the predicted intercept point and flight time for the BLUE SAM/SSM and determines whether the intercept is within the missile's capability.

JAMM - Subroutine JAMM determines the range at which a monostatic radar can detect a target in the presence of jamming.

BIDET - Subroutine BIDET computes detection ranges and times of detection for bistatic radars in a clear or jamming environment.

DTIMD - Subroutine DTIMD determines the real and imaginary roots of the fourth order polynomial used to solve for the bistatic radar detection times.

CPA - Subroutine CPA computes the coordinates of the closest point of approach of a target to a unit.

REACT - Subroutine REACT computes reaction time delays.

PRIOR - Subroutine PRIOR determines the most threatening target among those that a defensive system may engage at a given time.

RCHECK - Subroutine RCHECK evaluates a prospective target ship to determine if the target is above the raider's radar horizon and within the raider's maximum theoretical radar range.

TMDASM - Subroutine TMDASM determines if and when a RED target will close within a specified range of a BLUE unit.

TMDBOM - Subroutine TMDBOM determines the time when a RED raider will come within a given range of force center.

ZLNKA - Subroutine ZLNKA is a sorting routine.

TJSORT - Subroutine TJSORT is a sorting routine.

LOCTIM - Subroutine LOCTIM computes the raider position at a given time.

ASMTIM - Subroutine ASMTIM computes the ASM/SSM position at a given time.

RANDOM - Subroutine RANDOM generates uniform (0,1) random numbers.

HISTG - Subroutine HISTG provides a histogram and associated statistics of hits, hit intervals, and hits per minute for a specified BLUE unit.

DISPL - Subroutine DISPL provides a geographical plot of the BLUE unit positions.

RADIAN - Function RADIAN converts angles in degrees to angles in radians.

RAIDIS - Subroutine RAIDIS provides a geographical plot of the RED raider tracks and launch points.

SETIMX - Subroutine SETIMX provides the internal computer clock time.

2. MAIN

The simulation is initialized by MAIN which also compiles iteration results for the summaries. The MAIN program begins the first of its three principle functions by zeroing specified arrays. It then proceeds to read in the X array, the raider target list assignments (NRTGT), and the target lists (PLIST). The second principle function is to enter those initial values that will remain constant through all iterations into the various tables. MAIN's third principle function is the accumulation and printing of the statistical results.

The initial step in performing the above functions is the zeroing of the X array. In the next step, data are read into the X array by reading data cards in the format

(I10,5F10.3). The information is first read into an integer, IRT, and the array RXATA(5). From there, using IRT as the initial X address, MAIN fills the next five X array slots sequentially. X array addresses that are to remain 0.0 need not be read in unless they are within the neighborhood of the five addresses contained on an input card. In this case they must be specified 0.0. The sequence of reading data cards and filling the X array will continue until a card is read with the value 0 for IRT and 0.0 for the remainder of the card input. This is the flag for MAIN to proceed to the next step.

The program then obtains from the values previously read into the X array the starting values for ISEED, the seed value for the random number generator, and NI, the number of iterations to be played. End of game time is determined and the X array is printed as it was read in. MAIN now computes the weapon (RED ASM/SSM) horizon as follows:

$$\text{HORZ} = (\text{CURVATURE FACTOR}) \times (\text{CRUISING ALT})^{\frac{1}{2}}$$

HORZ is in miles and ALT is in feet. MAIN next converts all courses and bearings from degrees true to degrees in the cartesian coordinate system using the relationship:

$$\text{DEG(C)} = 450.-\text{DEG(T)}$$

All velocities are converted from knots to nautical miles per minute. Jammer and radar beam widths are converted to half beam widths in radians, and MAIN finds the fourth root of the raider and RED weapon radar cross sections. Next the

target list assignments and target lists are read in, and, if X(12) is set, MAIN prints the X-array, PLIST, and NTRGT as read in.

MAIN next fills out the ship table and the raid table. It counts up the number of BLUE missiles (both SAM and SSM) available, and, if X(15) has been set, MAIN prints the converted X array. If X(55) is set, MAIN calls SETIMX to start the internal timer.

MAIN now calls EFFECT to control the first iteration. Upon completion of the first iteration, MAIN prints the ASM table and the SAM-ASM-RAIDER table. It then computes and prints various statistics for this iteration and computes and prints cumulative statistics for all iterations thus far completed. If X(51) is set, the SHIP table is printed at the end of iteration one. If X(52) is set the RAID table is printed and if X(53) is set the SAM table is printed. If X(54) is set, all the random numbers used in the first iteration are printed, in the order of use.

At the end of iteration one, MAIN sets flags 9, 52, 53, 55, 56, 57, 58, 59, and 60 to 0. MAIN then loops back and calls EFFECT to begin the next iteration. Upon completion of the last iteration, additional statistics are printed and the program stops.

3. SUBROUTINE EFFECT

EFFECT controls each iteration. If X(55) is set for debugging, EFFECT calls subroutine GETIMX on entry and exit

to login and logout. EFFECT next calls JULIE to set the tables and arrays that were altered during the previous iteration back to their proper starting values. The simulation begins when EFFECT calls subroutine GETEV for the first event to be played. GETEV supplies EFFECT with the type of event to be played, NEXTEV, the time of the event, and a code identifying the type of event. If the event type returned by GETEV is 0, the iteration is over and the subroutine exits. If the event type is greater than 6, the program prints an error message and terminates. Otherwise EFFECT calls one of the following subroutines to continue the play:

SUBE1	for a RED raider detection and intercept event.
SUBE2	for a RED missile launch-target-detect-intercept event.
SUBE3	for a BLUE missile firing event.
SUBE4	for a RED ASM/SSM impact event.
SUBE5	for a BLUE missile kill event.
SUBE6	for a "set fire control channel free" event.

Upon return from one of the SUBE's, EFFECT again calls GETEV for the next event to be played. Event types used elsewhere in this manuscript correspond to the SUBE subroutine which plays the event.

4. SUBROUTINE JULIE

Subroutine JULIE initializes or resets those items that are required for each iteration. If X(55) is set, JULIE

calls GETIM upon entry and exit. JULIE is called by EFFECT and calls RANDOM, TMDBOM, STOREV, and EVENT.

EVENT is called to zero the events list, and to enter the end of game event into the events list. The following counters are then set to zero; NASM, NSAM, IFAG, IFBG, ITEMS, IFLASK, and IFIRST. The following arrays are zeroed; JAM, IHIT, ISAG, ISBG, STATS, TGTAV, IGAGE, NONO, JACK, and SAMASM. The RAID table and SHIP table are reset and the SAM table is zeroed. The missile batteries are reloaded and, if X(2) is set, the availability of each BLUE radar and launcher is determined. JULIE does this as follows. The first check is on the search radars; if at least one is operating, JULIE determines which fire control radars are operable. If no search radar is available, the program checks to see whether the horizon search mode for fire control radars is authorized, X(7), and if so, whether the ship in question has radars with this capability. If the ship has a search radar and fire control radar combination, or a search radar combined with active, HOJ, ARM, or some other type missile which does not require a fire control radar, the launch availability is checked. If the search radars are inoperative, the fire control radars are horizon search capable, and at least one is operable, the launchers are checked for availability. If the ship has no means of firing or of detection, it is marked a non-combatant and the next unit is evaluated. If the launcher can be coupled with a search/detection/acquisition system, the ship is marked as a G-ship,

the equipment status is entered in the NADAR array, and the next unit is evaluated.

For each RED raider, JULIE calls STOREV to store a type 1 event at time 0., and, if the raider carries ASMs or SSMs, a type 2 event is stored for launch time as determined by TMDBOM.

Finally, JULIE totals the number of BLUE SAM(SSM) batteries available, sets the RELOAD array to zero, and, if X(60) is set, prints the events list.

5. SUBROUTINE EVENT

Subroutine EVENT is called by JULIE. It enters the end of game time in the events list. If X(55) is set, EVENT calls GETIMX upon entry and exit. The event counter LOVER is set to one and the events list is zeroed. End of game time is set equal to the integer IT using the equation:

$$IT = 1000 \times (T + 0.0005)$$

where T is equal to the value stored in X(82). The end of game event, a type 0 event, is then entered in the events list along with the time IT. EVENT then returns to JULIE.

a. Entry GETEV

GETEV is an entry into Subroutine EVENT. It is called by EFFECT and calls GETIMX at entry and exit if X(55) is set. GETEV removes the first entry in the events array, IVENTS (1,1) and IVENTS (1,2), converts these back into event time, type, and participating units, and sends these three pieces of information back to EFFECT. The counter

LOVER is decremented and the entire events list is moved up one position. If the debugging switch X(60) is set, GETEV prints out TIME, NEXTEV, and IUNIT.

b. Entry STOREV

STOREV is an entry in Subroutine EVENT and its purpose is to place the given event in its proper place in the events list. STOREV is called by JULIE, SUBE1, SUBE2, SUBE3, SUBE5, and PRIOR. If X(55) is set, STOREV calls GETIMX upon entry and exit and prints the login/logout time. The inputs to STOREV are the time of the event, the type of event, and the code for the units involved. STOREV first checks to see whether the time the event is to be played exceeds the allotted game time. If it does, STOREV prints a message giving the time of the last event, type of event, and player code. If LOVER is greater than or equal to 1000, the event is lost and STOREV prints a similar message. If both tests are passed, STOREV combines the event type and player code into one 9 digit integer (ICODE). Time is converted to an integer using the same equation as is in EVENT. STOREV places the event in the events array by time. If the time is not unique, it proceeds to compare the stored values of ICODE to the one to be entered. These are ordered from smallest to largest. When the proper place is found, LOVER is incremented, and the remainder of the array is moved up one address. If no place is found to insert the event, including even just right before the end of game event, an error message is printed and the game stops. If the debug switch X(60) is set, STOREV prints the event stored.

6. SUBROUTINE REMOVE

Subroutine REMOVE is called by PRIOR when PRIOR discovers a more threatening target for the missile system being evaluated. If X(55) is set, REMOVE calls GETIMX upon entry and exit. REMOVE receives the code IUNYT from PRIOR. IUNYT is the (event type/player) combination that is stored in the events array. IUNYT was found by TARGET and evaluated by PRIOR as the next event to be played. REMOVE searches the events array for a matching code group. If it finds the group it removes both the code and the time and then moves the remainder of the array up one, and exits. If REMOVE can not find the code, it prints an error message. REMOVE then prints the events array and exits.

7. SUBROUTINE TARGET

Subroutine TARGET is called by PRIOR. Its purpose is to provide PRIOR with all Type 3 events which occur at the present game time. The input for TARGET is time and the outputs are IUNIT and MORE. If IFIRST is equal to zero, TARGET sets it equal to one. TARGET then converts time to the integer format of EVENT and compares it to the time in the array location indicated by IFIRST. If the times are equal, TARGET checks the event code. If it is a Type 3 event, TARGET increments IFIRST, sets MORE equal to one, and exits with the event code. If the times are not equal, or the code is not Type 3, MORE and IFIRST are set to zero and the subroutine exits. If MORE was set to one, PRIOR will

call again until MORE is set to zero. If X(55) is set, TARGET calls GETIMX each time it is entered or is exited.

8. SUBROUTINE SUBE1

SUBE1 is the RAIDER detection subroutine. It is called by EFFECT and in turn calls subroutines CPA, JAMM, STOREV, REACT, LOCTIM, RANDOM, TMDASM, BIDET, and, if X(55) is set, GETIMX on entry and exit. SUBE1 tracks the raider from its start of the game position to its end of game position and determines which BLUE units, if any, will be able to engage the raider. If it is determined an engagement is possible, detection delays, command and control delays, and equipment availability are checked to determine whether or not to enter a Type 3, or shoot, event in the events list array.

SUBE1 first sets flags NASA, NSURF, and NJ. If X(16) is set, SUBE1 checks the ASM counter to see if the BLUE force has been fired upon. If X(16) is set and NASM is zero, SUBE1 stores a Type 1 event at game time plus 2 minutes and then exits. Otherwise, the raider's altitude is checked to determine whether the raider is an aircraft or surface/subsurface unit, and then the applicable raider characteristics are drawn from the X-array.

Each BLUE ship is next queried to determine whether it can engage the raider. If the ship has been sunk, or if it is a non-missile ship, the NONO table is set to 7 and the next unit is evaluated. The maximum missile range of the operable systems on the BLUE unit is obtained. The distinction between surface and air targets is made by comparing

target altitude to the fifty-foot ceiling for enemy surface units and the fifty-foot floor for enemy aircraft. A missile system must be designated as a surface to surface, or surface to air system when the system characteristics are input. There is no cross matching of systems to targets. SAM's are fired only at aircraft and ASM's, SSM's only at ships.

TMDASM is called to determine whether the target will enter the BLUE unit's missile envelope. If not, the NONO table is set to 9 and the next unit evaluated. If the target will enter the envelope after the end of game time, the NONO table is set to 8.

When it has been determined that the target can be engaged, the target CPA is obtained and the ship's engagement opportunity counter is incremented.

The detection phase begins with a check of the search radars. Each BLUE unit is allowed up to three. If the radar is operable, the clear detection range, jamming environment detection range, combined radar horizon, and theoretical maximum radar detection range are compared. The minimum of these is the radar's detection range for the target in question. This range is compared to that of the other search radars on board, and the maximum is taken as the ship's detection range.

The between radar comparison is made by converting detection ranges into time and adding in the reaction time delays obtained from REACT.

If there is no search radar operational, SUBE1 checks to see whether the target can be detected in the horizon search mode. If there has been no detection and the BLUE unit is operating a bistatic search radar, the subroutine checks to see whether BIDET indicated two detection zones. If so, the search radar portion of SUBE1 is redone using the second bistatic zone. If there remains no detection, or no radar capable of detection, the NONO table is set to 2 and the next BLUE unit evaluated.

Given a search radar detection, SUBE1 proceeds to evaluate the missile systems for fire control acquisition. This is done by obtaining the maximum fire control radar range from among those radars available, and converting this to a time as was done in the search radar algorithm. If the missile of a system requires no fire control radar, the maximum missile range is used as that system's acquisition range.

Having determined the maximum acquisition range, the probability of correct identification is compared to a random number drawn from RANDOM. If the ID check declares the target non-hostile, the NONO table is set equal to 3 and the next BLUE unit is evaluated. Otherwise, the time the target will be acquired is determined by calling TMDASM.

The reaction times for weapons direction equipment delays, target assignment, and acquisition (if the missile requires a fire control radar) are obtained from REACT and added to the search radar detection time. The last time to shoot is determined using the time the target leaves the maximum fire control range, and the SAM/SSM velocity.

The firing delay is obtained from REACT and added to the greater of the detection time and the acquisition time. The "shoot" time is compared to the last time to fire, and if the shot is still possible, the program stores a shoot, Type 3, event for each director-launcher combination in operation. If the missile requires no director, the number 7 is stored as the channel number, and only one shoot event is stored for that system. If the unit requires a director, no channel number is assigned.

If the delays have precluded a firing, SUBE1 checks to see whether there was a second bistatic detection. If so, it returns to the search radar portion of the algorithm and proceeds as above evaluating the second bistatic detection zone. Otherwise it sets the NONO table equal to 5 and processes the next BLUE unit.

The horizon search portion of SUBE1 is entered as described above. The program checks the NADAR table to see if the directors can operate in the horizon search mode. If so, the program proceeds in the same way as the search algorithm, using the fire control radar parameters. Having determined the detection time, the decisional and reaction delays for horizon scan mode are obtained from REACT. The shoot time is determined to be the detection time plus the acquisition time, plus the maximum of the firing time and decision to fire time. A range check is made by calling TMDASM and if the time to fire is less than the last time to fire, a Type 3 event is stored for each director operable in the horizon search mode.

After all the BLUE units have been processed, SUBE1 exits calling GETIMX if flag X(55) has been set.

9. SUBROUTINE SUBE2

SUBE2 is the ASM/SSM launch and detection subroutine. It is called by EFFECT and in turn calls RCHECK, REACT, STOREV, BIDET, RANDOM, TMDASM, TJSORT, CPA, LOCTIM, JAMM, and if X(55) is set, GETIMX on entry and exit.

The inputs to SUBE2 are launch time and raider number. The subroutine first checks the RAID table to see whether the raider has already been shot down or sunk. If so, the subroutine exits. Next the program checks the flag IFLASK to determine whether any RED ASM/SSM's have been fired. If IFLASK is greater than zero, the subroutine proceeds to check whether the launch time is greater than TMAX and exits if it is. If IFLASK equals zero, SUBE2 sets IFLASK to one and TMAX, the time by which all ASM's must be launched, to present time plus X(84). SUBE2 now retrieves the raider speed and, if the raider is an aircraft, determines the ASM launch interval, sets IFLASK equal to 2, and determines the total number of ASM's on board. If the raider is a surface unit; and no ASM's have been fired, IFLASK is set to 0.

SUBE2 determines which of the two possible missile types has the longest firing range, (firing range is measured from coordinate (0,0)). The missile parameters are drawn from the X vector, and the launching sequence begins.

The launching of ASM's is done by drawing a series of uniform (0,1) random numbers, depending upon how many missiles

are to be launched, and ordering them. The exact launch time of each ASM becomes the present time, plus the next random number times the launching interval. The launching of SSM's from surface units begins with the first launch at time plus some portion of the interval specified in X(86). Subsequent surface launches are at fixed increments, X(1809).

Having determined when, and in the case of surface to surface launches, how many RED missiles are to be launched, the targeting phase beings. LOCTIM is called to insert the raider position at launch into the RAID table. The raider target list is located and a temporary target list is constructed. Each ship on the raider's target list is cycled through RCHECK to determine whether it is afloat, above the radar horizon and within radar range. If all these tests are passed, the ship is entered on the temporary target list by putting the values from the original target list in the next slot of the temporary target list. Once the target list has been formed, a random number, Z, is drawn from RANDOM and the first ship with a cumulative probability of being targeted greater than Z is designated the target. If there is none, the first ship on the list is taken. A check is made to see whether this ship has been designated a non-radiating picket. If not, SUBE2 proceeds to the detection phase. If the target chosen is a non-radiating picket, checks are made to see whether the raider can correctly identify the target. This is doen by determining whether the raider is within X(23) miles of the target. This

measurement is done in the horizontal plane. If the raider is close enough to the target, RANDOM is called for a random number to compare with the probability of correct identification. If the picket fails to qualify as a target, it is eliminated from the target list and the process starts again. If, at any time the situation arises where there are no targets on a raider's target list, launching stops and an event Type 2 is stored for time plus three minutes.

Upon acquiring a target, the ASM/SSM is considered launched. A random number is drawn and compared to the launch reliability. The ASM table is filled out and, if launch was unsuccessful, the NONO table is set equal to 1 and the next missile processed. Upon an unsuccessful launch, a check is made to see whether there is to be a second SSM in the same salvo. If so, the time is not advanced for this launch.

Assuming a successful launch, the detection phase begins. The target ship's position is stored in the RAID table for use in BIDET, but otherwise, the detection sequence follows that outlined in SUBE1.

When all of the first type of missiles have been launched, and if the raider is carrying a second type of missile, SUBE2 decides whether or not the raider has reached its second launch point. If so, the appropriate parameters are extracted and the launching continues; otherwise an event Type 2 is stored for the new launch time and the subroutine exits. When there are no second type missiles, the subroutine exits after the last launch.

The exit sequence consists of checking X(58), (if set the NONO table is printed), and X(55), if set, (the exit clock time is printed). The NONO table codes for SUBE1 and SUBE2 are:

0 System can engage the target.
1 The ASM failed at launch.
2 The ship did not detect this target.
3 The missile or raider was not identified as a target suitable for engagement.
4 The ship can not acquire the target.
5 Reaction delay was too long.
6 The missile will impact prior to coming into max SAM range.
7 Non missile ship.
8 Detection will not occur until after end of game.
9 Can not engage.

10. SUBROUTINE SUBE3

This subroutine evaluates the engageability of the target in light of the current situation at the proposed launch time. SUBE3 is called by EFFECT, and it in turn calls PRIOR, STOREV, CPA, TIMMY, and, if X(55) is set, GETIMX on entry and exit.

The inputs to SUBE3 are event time and a participant code. The code is an integer of the following type, IIIJJKLM, where III is the target number, JJ is the firing ship, K is the missile system, L the director, and M is the channel number. The subroutine breaks down the code and then checks the appropriate portion of the SHIP table to determine whether the firing ship has been sunk, (if X(5) has been set, this check will indicate the ship has not been sunk

even if it has absorbed more hits than are considered necessary to put it out of action). If the ship has expended the magazine of this missile system, the subroutine exits. Having established the credibility of the firing ship, SUBE3 determines whether the raider has been shot down or sunk, and if so, it exits.

SUBE3 now determines the maximum missile range for the system under consideration and compares this with the raider's CPA. If the target will not enter this maximum missile envelope the subroutine exits. PRIOR is called to determine whether this ship/system/director combination has another shoot event at the present game time and, if so, if that target is more threatening. PRIOR logic will consider the closest target as most threatening. If PRIOR returns the same target, the subroutine continues. If not, it checks out the target as above and exits or continues as appropriate.

If the target has not been destroyed, SUBE3 checks the coordination set-up. If both the fleet and the firing ship are coordination capable, the subroutine checks the target availability. If the target is under engagement, the subroutine calls STOREV to store a Type 3 event at the time the target will become available. If the target remains engageable, SUBE3 checks the NONO table. If the value 0 is found the event continues. If not, the subroutine exits.

The subroutine now goes to the channel assignment phase. If the SAM or BLUE SSM requires no director, channel number

7 has already been assigned in SUBE1 or SUBE2, and the flag ICOT is set to 0. If the missile requires a director for part or all of its flight, and a channel has been assigned on a previous run through SUBE3, the subroutine checks to see whether the assigned channel is busy. If it is, ICOT is set to 1; if not, ICOT is set to 0. If the missile has not been assigned a channel previously, the availability of a channel is checked. A free channel, if found, is assigned and ICOT is set to 0; otherwise a search is made to determine which channel will first become available and this one is assigned. If at this point all channels are busy and the director is required for the full SAM/SSM flight, STOREV is called and a Type 3 event stored for the time the director will become available.

If the systems all indicate they are engaged in an intercept and upon searching the SAMASM and SAM tables no record of this can be found, the program terminates after printing an error message.

SUBE3 now proceeds to check whether the firing ship itself is engaging the target. If it is the subroutine exits. If the target is an ASM or SSM, the subroutine checks to see that the target will not impact prior to BLUE missile launch. If it will, the program exits.

At this point, if ICOT equals 1, the channels were all considered busy and the BLUE missile only requires the director for terminal homing. SUBE3 checks the SAMASM listing to determine when the channel will be available and stores a Type 3 event.

If ICOT equals 0, SUBE3 calls TIMMY to determine the intercept position, single shot kill probability, SAM/SSM flight time, and the intercept possibility given the BLUE missile flight and warhead characteristics. If TIMMY returns the possibility flag -1, the intercept is not possible, but may be in the future. SUBE3 stores a Type 3 event for present time plus six seconds. If the indicator is zero, the intercept is not and will not be possible, and the subroutine exits. If the indicator is one, the intercept is now possible and the program continues. If the intercept was possible, but the intercept point was in the hazard zone of another BLUE unit, TIMMY returns the indicator two. In this case, SUBE3 again stores a Type 3 event for present time plus six seconds.

If the SAM/SSM requires the director for only the terminal phase of flight, SUBE3 determines whether the director can be scheduled for the intercept. If not, the subroutine stores a Type 3 event for the time the director will be free, minus flight time, plus terminal homing time, plus 0.06 seconds.

If scheduling is not needed, or the director will be available when needed the missile is considered launched. The SAM-ASM-RAIDER and SAM tables are filled in and missiles on board and in the fleet counters are decremented. If there is coordination, and the firing ship is coordination capable, the target availability is up-dated. The launcher reload time is determined and stored. The channel

availability indicator is set to 1 and a Type 5 event is stored for intercept time.

Prior to exit, if X(9) is set, SUBE3 prints out the firing ship number, the target number, and the reason for exiting the subroutine are printed. The breakdown for the REASON code for SUBE3 follows:

0	Blue Salvo fired.
1	Firing ship sunk or out of action.
2	Target being engaged.
3	Target already destroyed.
4	Firing ship out of missiles.
5	Director required for entire missile flight and is not available.
6	Firing ship already engaging the target.
7	Missile requires director only part time but all channels are busy.
8	NONO table prohibits engagement.
9	Launcher not available.
10	ASM will impact prior to SAM launch.
11	Director cannot be scheduled for the intercept.
12	Director operation in horizon scan mode, busy.
13	Target will not close BLUE missile envelope or TIMMY indicates no intercept.
14	TIMMY indicates target may enter envelope later.
15	TIMMY indicates target intercept point is too close to another BLUE unit.

11. SUBROUTINE SUBE4

SUBE4 determines whether the RED missile failed in flight, and if not, increments certain counters indicating ship hits and possible sinking. SUBE4 is called by EFFECT and it in turn calls RANDOM, and, if X(55) is set, GETIMX on entry and exit.

SUBE4 first breaks down the input code into the RED ASM/SSM number, and the BLUE target ship number. The code enters SUBE4 as the integer RRRBB. It then checks to see whether the ASM/SSM has been shot down, or had its launch negated due to the loss of the launching raider prior to the actual missile launch time. If neither is the case, the probability of successful flight is drawn from the X array and RANDOM is called to produce a random number. If it is determined that a failure occurred, the ASM table is set to 3 and the subroutine exits. Otherwise the target ship is assumed to have been hit and the appropriate counters are incremented. If X(5) is not set, the subroutine compares the number of hits taken to the amount of damage the ship can withstand, and if too many hits have been taken, declares the ship sunk.

12. SUBROUTINE SUBE5

SUBE5 evaluates the BLUE missile intercept and performs checks on other ASM/SSM if the target shot down or sunk was a RED raider. SUBE5 is called by EFFECT and it in turn calls STOREV, REACT, RANDOM, and if X(55) is set, GETIMX on entry and exit.

SUBE5 is called with an input variable of salvo number. Using this, SUBE5 gets the target number, firing ship number, missile system, director, and channel number from the SAM-ASM-RAID table. The director reassignment and reacquisition delays are determined and stored, fleet and individual ship

statistical data are taken, and a check is made to insure that the target is still engageable. If the target has already been sunk or shot down, the SAM-ASM-RAID table is set to -1, indicating an overkill. If the target is an ASM/SSM that failed in flight or has already impacted, the salvo is determined to have been a failure and the SAM-ASM-RAID table is set to zero. If the target is engaged, the probability of BLUE missile successful flight and support is pulled from the X array, and the single shot kill probability is removed from the SAM-ASM-RAID table. RANDOM is called to provide a random number. Success is determined by comparing PK to the random number drawn. This is done by determining PK as follows:

$$PK = PS \times (1-(1-PKSS)^{n})$$

Where PS is the probability of successful flight, PKSS is the single shot kill probability, and N is the number of BLUE missiles in the salvo. If the random number is less than PK, the shot was successful. If the shot was unsuccessful and the missile requires a director, the channel is released and Type 3, shoot, event is stored for present game time. If the missile doesn't require a director, just the shoot event is stored, and the subroutine exits.

If the shot was successful and the target was an ASM/SSM, the SAM, SAM-ASM-RAID, ASM, and kill counters are updated, a Type 6, channel free, event is stored, and the subroutine exits. If the target destroyed was an aircraft, or if the number of hits has been sufficient to disable a

surface raider, the following steps are taken prior to the regular table update and exit. A check is made to determine whether the raider has any ASM's or SSM's aboard. If so, the ASM counter is incremented and the appropriate numbers are entered in the ASM table indicating that these missiles were lost with the launching platform. Next the ASM table is checked to locate any missiles launched by the raider just destroyed. When one is found, its launch time is compared to raider kill time, and if the launch time is greater, entries are changed in the ASM table to correspond. Upon completing the search, the program continues to exit where it checks X(55), X(56), and X(58) for debug output.

13. SUBROUTINE SUBE6

SUBE6 releases the fire control radar channel at the time of the event. SUBE6 calls GETIMX upon entry and exit if X(55) is set.

The input value to SUBE6 is an integer code AABCD, where AA is the firing ship number, B is the missile system, C is the director number, and D the channel number. After breaking down the code, SUBE6 sets the appropriate portion of the CHANEL array to zero, and exits.

14. SUBROUTINE TIMMY

TIMMY computes the predicted intercept point and flight time for the BLUE SAM/SSM and determines whether the intercept lies within the intercept contour. TIMMY is called by SUBE3 and TIMMY in turn calls TMDASM, ASMTIM, RADIAN, ZLNKA, LOCTIM, and if X(55) is set, GETIMX on entry and exit.

Inputs to TIMMY are target number, firing ship number, missile system number, present target position, and present game time. Outputs are single shot kill probability, flight time, and an indicator flag which says the intercept is possible, is not and will not be possible, or is not but may be possible in the future.

Using the target number, TIMMY decides whether the target is a raider or an ASM/SSM and determines the end of game position for raiders and target ship position for an ASM/SSM. If X(8) is set, firing sectors have been assigned and TIMMY checks to ensure that the assigned firing sector and the launcher train limits permit a launch. If launch is prohibited, REASON is set to 2, flag IND is set to zero, and the subroutine exits. If the launch is possible, there may be as many as two firing zones. These two occurrences are shown in Figure B1.

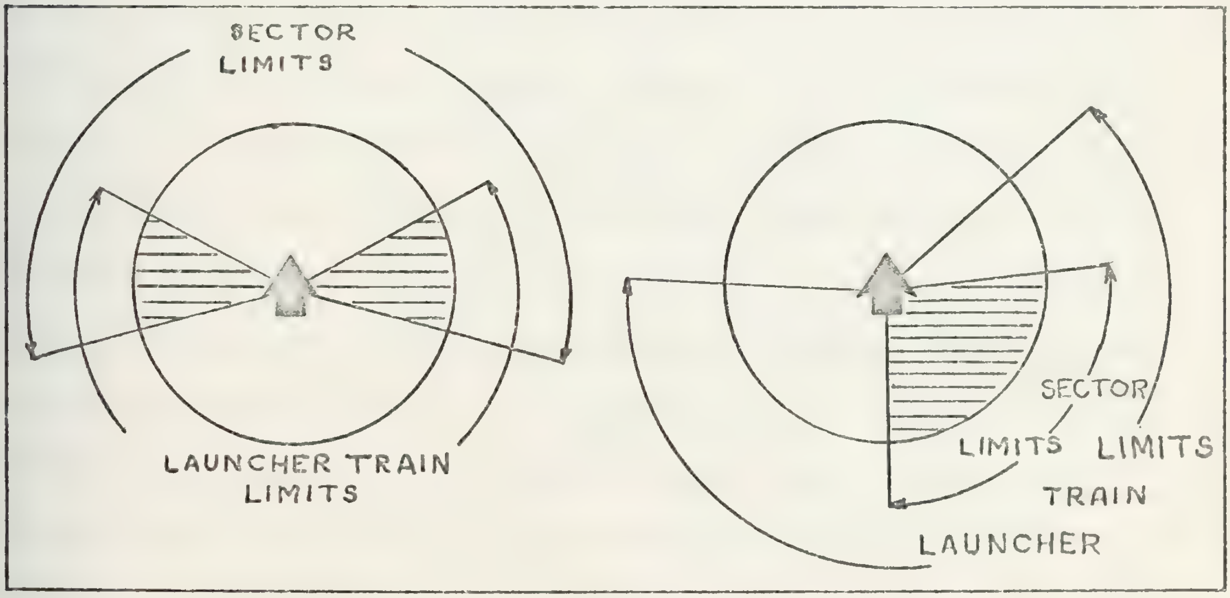


Figure B1
One or Two Firing Zones

Using the results of the ZLNKA reordering of the sector limits and launcher train limits, TIMMY determines whether there are two zones or one, and which of the bearings constitute the actual firing zone, or zones, limits. If no sectors have been assigned to the fleet, or this unit, the firing zone limits coincide with the launcher train limitations.

TIMMY next checks target altitude against the maximum SAM altitude. If the target is too high, REASON is set to eleven and the subroutine exits. Otherwise, the intercept parameters are determined. These intercept parameters are the values entered into the X-array that approximate the actual intercept contour. The intercept parameters are A, B, N, SLOPE, and SEEK. The actual intercept contour depends on target size, speed, and altitude as well as missile parameters. There are usually more than one contour for any given missile system. The actual contours are found in the various technical publications dealing with the specific missile. OP-3594, Performance and Installation Characteristics Surface Missile Weapon Systems, also contains general contour nomograms, and the Applied Physics Laboratory of Johns Hopkins University has developed computer simulations which generate contours. A typical contour, along with the TIMMY approximation, is shown in Figure B2. A is the off-range capability, B is the down-range capability, and N is a degree of curvature.

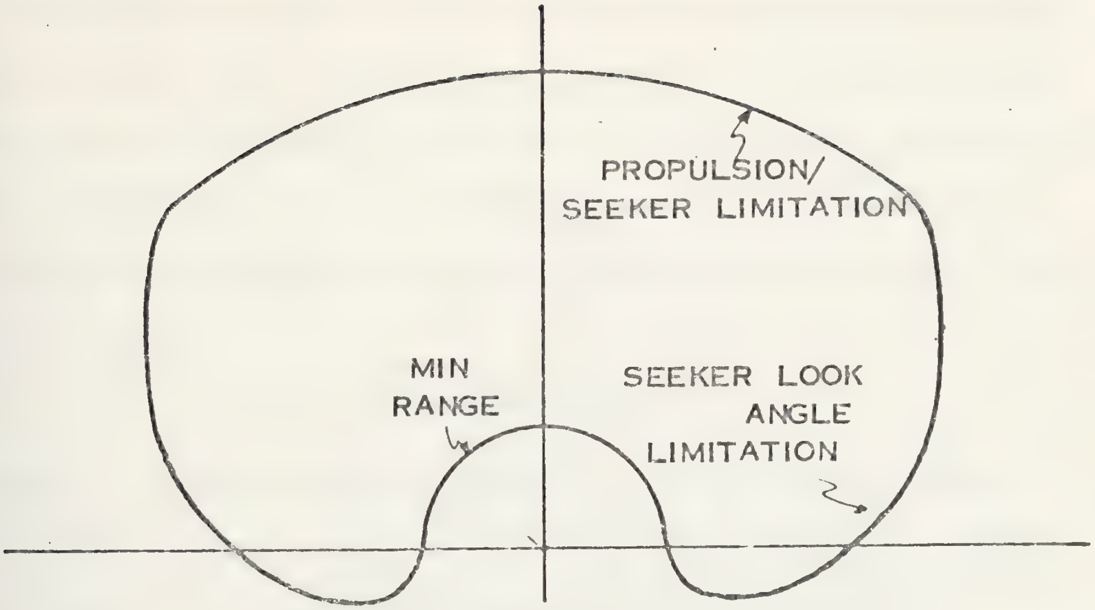


Figure B2a
The Actual Intercept Contour

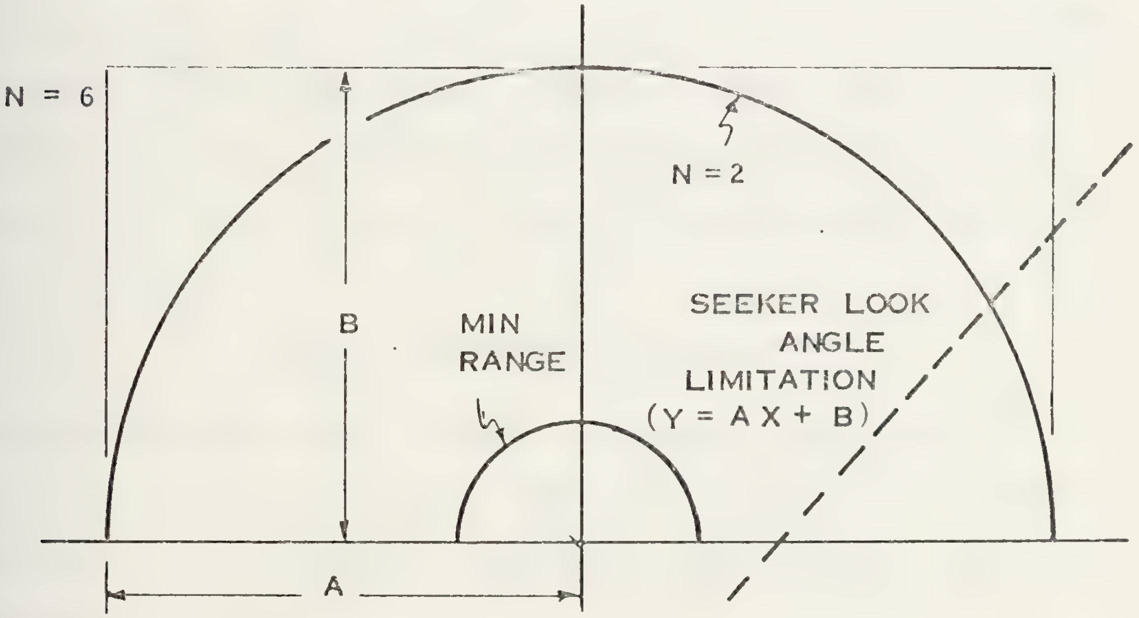


Figure B2b
The Approximation of the Contour

The maximum missile range for the given target altitude is determined, and if the target will not enter this range, as determined by TMDASM, TIMMY exits after setting REASON to seven. If the target is an ASM/SSM and the target ship is the firing ship, target course is found and SAM flight time is determined by:

$$FT = DLT/(SSPD+VEL)$$

where DLT is the distance between the firing ship and the target, SSPD is the speed of the SAM, and VEL is the speed of the target. In this case the PK that is returned to SUBE3 is that for a non-crossing target.

If the target ship is not the firing ship, or the target is a raider, the following angles are determined: ALPHA, the angle between the target flight path and the line of sight at launch, and THETA, the angle in Cartesian coordinates of the present line of sight. The quantity GSINE is determined by:

$$GSINE = SIN(ALPHA)*(VEL/SSPD)$$

If the absolute value of GSINE is greater than one, the intercept is impossible and TIMMY exits after setting REASON equal to ten. Otherwise, the angles GAMMA, BETA, and DELTA are computed.

$$GAMMA = ARCSIN(GSINE)$$

$$BETA = 180° - GAMMA - ALPHA$$

$$DELTA = 180° - BETA$$

GAMMA is the angle between the SAM/SSM flight path and the line of sight, BETA is the angle between the SAM/SSM flight path and the target flight path, and DELTA is the compliment of BETA. If X(59) is set, the values for target number, firing ship number, ALPHA, BETA, GAMMA, present target position, GSINE, and present range to the target are printed. PK for this type of target is determined by DELTA. If DELTA is greater than 45°, the target is declared a crossing target and the appropriate PK is retrieved from the X-array. Otherwise, the probability of kill for a non-crossing target is retrieved. Flight time is determined by:

$$FT = DET * SIN(ALPHA)/(SSPD * SIN(BETA))$$

Using present time plus flight time for the input, TIMMY now calls LOCTIM or ASMTIM, as appropriate, to determine the intercept coordinates. The range to the intercept is computed and compared to the minimum missile range. If the range is too short, IND is set to minus one, REASON to four, and the subroutine exits. The launch bearing is calculated and the first of two possible sets of firing zone bearings are compared to determine whether the launch bearing is within the firing bearings. If it is not, TIMMY checks to see if there was a second firing zone, if so it checks this one, otherwise, IND is set to minus one, REASON to three, and TIMMY exits. If the intercept angle is good, the intercept parameter is checked. A, B, and N are combined to form the equation:

$$(X/A)^N + (Y/B)^N = 1$$

A value of two for N results in a circle or an ellipse. A value of six results in a near rectangle. Fractional values for N are permitted.

The "ellipse" is translated so that its center is on the firing ship, and rotated so that the positive Y axis is opposite to the line of flight of the target. The intercept coordinates are substituted into the equation, in absolute value, and if the resulting number is less than or equal to one, the intercept will be within the ellipse. The next check is the seeker limit test. The y intercept value and the absolute value of the x coordinate are entered into the equation:

$$Z = YI - SLOPE * XI$$

If Z is greater than or equal to SEEK, the problem continues. If not, TIMMY exits after setting REASON to six. The subroutine now checks the X-vector to determine whether there are any restrictions on how close an intercept can be to another friendly unit. If there are, the hazard zone is constructed. If the intercept falls within the hazard zone, REASON is set to nine, IND is set to two, and TIMMY exits.

If the problem has progressed this far, the intercept is considered possible and the BLUE missile salvo is launched while IND is set to one. If the target is an ASM/SSM and the firing ship is the target, the program exits. If not, the target altitude is figured into the flight time prior to return to SUBE3. If X(9) is set, TIMMY prints out the ship number, target number, IND value, and REASON prior to exit.

Reason codes as used in TIMMY

1	Not used.
2	No firing zones for this system.
3	Firing bearing outside sector.
4	Target too close.
5	Target intercept point outside engagement contour.
6	Target beyond seeker limits.
7	Target beyond range and outbound.
8	Intercept after ASM/SSM impact.
9	Target too close to BLUE unit at intercept.
10	GSINE greater than one.
11	Target too high.

15. SUBROUTINE JAMM

The subroutine JAMM determines the range at which a monostatic radar can detect a given target in a multiple standoff and self-screening jamming environment.

The calling routine, either SUBE1 in the case of raiders, or SUBE2 in the case of missiles, first determines that there are jammers in the problem and that at least one jammer is on the same frequency band as the detecting radar. If both situations obtain, subroutine JAMM is called.

JAMM initially checks to see if the target will close the detecting unit within the minimum of the clear environment, radar horizon, and theoretical range of the radar. If the target will not close within this minimum range, the subroutine is exited with a flag set to show that detection would not occur. In the case where the target will enter this minimum range, JAMM computes the time at which the target will arrive at the closest point of approach (CPA) to

the detecting radar. Appropriate checks are made for stationary targets and targets with only minor changes in their X or Y position components. JAMM next obtains the bearing from the radar to the target at the CPA position for use in selecting the appropriate side-lobe coefficient. Individual radars are then checked to see if they have been shot down prior to the target arriving at CPA (applicable only for missile detections), if they are jamming on the frequency band of the detecting radar, and if they are above the detecting radar's horizon. If all of the conditions are met, the bearing from the jammer to the jammer's jamming target is found in order to determine whether the detecting radar is within the main beam or the side-lobe of the jammer. The jamming power arriving at the radar from the individual jammer is then computed, taking into consideration the power of the jammer, the range from the jammer to the detecting radar, and the side-lobe/main beam relationship between the detecting radar and the individual jammer. The jamming power arriving at the detecting radar is then summed over all of the jammers and used to compute the burn-through range for the radar against the specified target. Prior to exiting the subroutine, the range to the target's CPA to the detecting radar is checked to ensure that it is less than the burn-through range. If the distance to CPA is greater than the burn-through range a flag is set indicating that detection did not occur due to CPA considerations. Otherwise the subroutine returns as the detection range the minimum of the clear, jamming, radar horizon, and theoretical ranges.

16. SUBROUTINE BIDET

This subroutine computes the number of detection zones, ranges, and times of detection for a bistatic radar in either a clear or jamming environment. BIDET is called by SUBE1 and SUBE2, and it in turn calls GETIMX on entry and exit if X(55) is set.

BIDET begins by setting the initial values of aircraft/ ASM start position, final position, altitude, and velocity. The transmitter and receiver positions and radar antenna height are established for the bistatic system under consideration. A check for non-moving targets is conducted prior to entering the closest point of approach (CPA) routine. In the case where the target has moved less than 0.1 nautical mile in both the X and Y direction, the target's speed is considered to be zero and the target enters a special loop to determine whether it is detectable at its initial position within the constraints of both radar horizon and radar signal strength.

For the moving target, the CPA of the target's projected track to the transmitter is determined by solving simultaneously the equations of the target's track and the line perpendicular to the target's track and passing through the transmitter location. The CPA to the receiver is solved in a similar manner. If movement in either the X or Y directions is less than 0.1 nautical mile, the CPA is established by setting the CPA coordinate for the small changing axis to the target's original position corresponding coordinate and

the alternate coordinate to the corresponding alternate coordinate of the transmitter or receiver. For example, if the X coordinate of the target's positions changes less than 0.1 nautical mile, the CPA to the receiver is set to the X coordinate of the target's initial position and the Y coordinate of the receiver's position.

The radar horizon for the transmitter and the receiver are then compared to the distance to their respective target track CPAs to determine whether the target enters the radar horizon of both the transmitter and the receiver. If it fails to enter both, the routine is exited with a no detection. Otherwise, the times that the target first appears above and disappears below the transmitter and receiver radar horizons are computed. The time interval that the target is simultaneously above both horizons is determined by taking the maximum of the appearance times and the minimum of the disappearance times. If the target is never simultaneously above both horizons; or the appearance time is greater than maximum game time; or the disappearance time is prior to start of game time, the subroutine is exited with a no detection.

Next, detection times for the target based on radar signal strength are computed, and the intersection of these time intervals with the above joint radar horizon time interval determines the time during which the target is detected. No detection occurs if the intersection of the two time sets (i.e. radar strength detection and radar horizon detection) is the null set.

If a detection has occurred in the clear environment, the subroutine checks to see whether any jammers are in use and if they are on the same frequency band as the bistatic radar. If jammers are in use, the time that the target arrives at its midpoint in the bistatic detection envelope is determined. This time is used in arriving at an average jammer position to compute the jamming power at the radar during the detection phase. This will tend to provide a somewhat conservative estimate of detection ranges in the face of jamming because the jammers are in general going to be nearer to the radar and the range square losses of the jamming power will be reduced. In the case of the stationary target, midpoint time is set to an arbitrary three minutes after start of game time to allow for some movement of the jammers toward the force. The subroutine then adds the jamming power from each jammer. It does this by checking all of the raiders to determine if the individual raider has been shot down prior to the midpoint time, and if the jammer is above the radar horizon and is jamming on the frequency band of the radar. If these conditions are met, the subroutine examines the geometry of the jammer's position and the radar to determine the relationship between the jamming and radar antennas. With this relationship, the appropriate side-lobe/main beam antenna coefficients are used to adjust the jamming level.

The constant in the bistatic range equation is then adjusted to reflect the jamming environment and the computation

previously conducted in the clear environment are repeated to determine whether detection will occur in the jamming situation.

The subroutine exits with the number of detection zones which occurred; the time and range of initial detection in the first zone, the time of last detection in the first zone; and, if applicable, the time and range of first detection in the second zone along with the time contact is lost in the second zone.

17. SUBROUTINE DTIMD

Subroutine DTIMD is a double precision subroutine that determines the real and imaginary roots of the fourth order polynomial which is used to solve for the bistatic radar detection times. The subroutine employs the Newton-Raphson iterative technique with the final iteration on each root performed using the original polynomial rather than the reduced polynomial to avoid accumulated errors in the reduced polynomial. The subroutine was obtained from the Naval Postgraduate School Computer Center library.

18. SUBROUTINE CPA

Subroutine CPA obtains the closest point of approach of a target's track to a reference point by solving the simultaneous equations of the line representing the target's track and the line through the reference point and perpendicular to the target's track. Checks are conducted for target tracks which pass through the reference point,

represent stationary targets, or targets which have only minor changes in either the X or the Y direction.

19. SUBROUTINE REACT

Subroutine REACT allows the use of reaction time delays through the use of probability distribution functions. This subroutine is similar to, if not identical to, one developed for use in FLOATS by APL at the Johns-Hopkins University. The distribution functions may be entered for seven classes of delay. They are:

1 Target detectability to actual detection.
2 Detection to ID and designation to the weapons direction equipment.
3 Director assignment delay.
4 Director acquisition delay.
5 Firing delay.
6 Target detectability to detection for horizon scan mode.
7 Decision delay in horizon scan mode.

Within these class areas, up to five separate types may be designated. REACT uses the type and class numbers to determine a delay time which it returns to the calling subroutine. REACT is called by SUBE1, SUBE2, and SUBE5. REACT in turn calls only RANDOM.

The inputs to REACT are the class number and type, and the output is the delay in minutes. The class number is used to locate that portion of the X-array where the delay is stored. The type number is used to localize the address within the area. In employing its Monte Carlo technique, REACT calls RANDOM and converts the returned uniform (0,1)

number to an integer. If this integer is 10, the subroutine sets it equal to 9. If the integer is zero, the RANGE, defined as the difference in time between two adjacent blocks, is set equal to the value in the first block. Otherwise, the address is determined using the class and type numbers and then adding on the integer. The delay consists of two parts. The first part is the time in the address block. The second part is determined by drawing another random number and multiplying it by RANGE. Except in the case where the integer is zero, RANGE is determined by subtracting the time in the address block from that in the next highest block. In the "zero" case, the total delay consists of this fraction of RANGE. In all other cases, the fraction of RANGE is added to the time stored in the address block to obtain the total delay. At this point REACT returns to the calling routine.

As an example of a distribution function, consider the waiting time for an aircraft for a catapult launch. Data is available for one hundred aircraft. The maximum waiting time was seven minutes. The distribution of waiting times was as follows:

length of wait	0-1	1-2	2-3	3-4	4-5	5-6	6-7
frequency	10	40	15	15	5	5	10

Figure B3

An Example of Waiting Time

The plot of length of time waiting against number of occurrences would look like this:

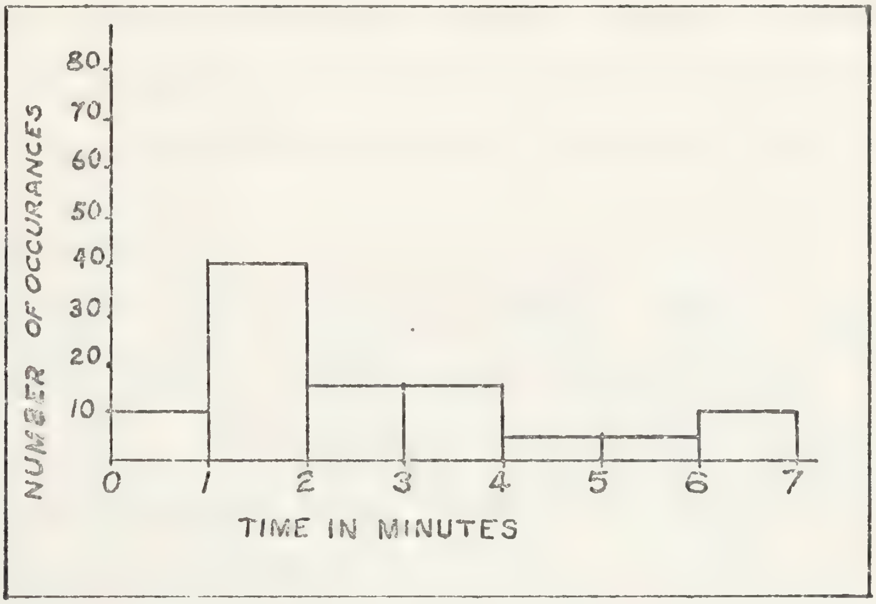


Figure B4
Histogram of Waiting Times

The probability of waiting between 0.0 and 1.0 minutes is 0.1, the probability of waiting between 1.0 and 2.0 minutes is 0.4. When the histogram is transformed into a cumulative probability distribution function, the following results.

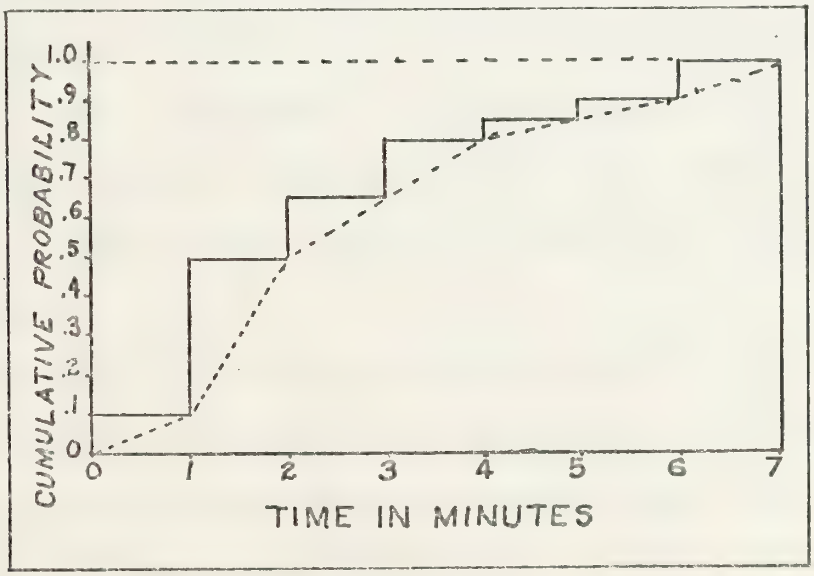


Figure B5
Cumulative Distribution Function of the Waiting Times

This distribution is what is entered in the X-array. The first block would contain the time for .1 cumulative probability. This would be one minute. Block two that for .2 cumulative probability, or 1.25 minutes, and so on up to block ten which would have entered a seven for seven minutes.

20. SUBROUTINE PRIOR

Subroutine PRIOR is called by SUBE3. PRIOR calls REMOVE, STOREV, LOCTIM, ASMTIM, TARGET, and if X(55) is set, GETIMX on entry and exit. The purpose of PRIOR is to determine the most threatening target among those that a system may choose from at present game time.

PRIOR first computes the value CHECK for the target being compared. CHECK is defined as maximum missile system range divided by present target range. TARGET is called to provide PRIOR with a candidate for comparison. The same measure of threat is obtained for the candidate target and stored in CHERRY. If the present value in CHECK is greater than or equal to CHERRY, PRIOR goes to the next candidate, if there is one. If CHERRY is greater than CHECK, the values of target number, channel number, and target position are saved. CHECK is made equal to CHERRY and PRIOR seeks a new comparison.

If the value returned by TARGET in MORE is not zero, there is another candidate to be evaluated. If MORE is zero, there are no more comparisons to make and the final section of PRIOR is entered. The stored value of most threatening target number is compared with the target sent to PRIOR

originally from SUBE3. If they are the same, the subroutine exits. If PRIOR has found a more threatening target, REMOVE is called to take the type 3 event associated with the new target out of the events list. STOREV is then called to enter a type 3 event for the target being intercepted.

The debug switch X(9) is checked at exit and if it is set, old target, new target, missile system (in the code AABC were AA is ship number, B is system number, and C is director number), old channel, and new channel are printed. X(55) is checked and PRIOR returns to SUBE3.

21. SUBROUTINE RCHECK

Subroutine RCHECK evaluates the prospective target ship to determine if the raider can in fact "see" the target. RCHECK is called by SUBE2 and RCHECK calls GET1MX on entry and exit if X(55) is set. The inputs to RCHECK are the raider number and proposed target ship number. The two dimensional distance between the two units is computed. The antenna heights on the target ship are compared and the tallest one is used to determine the ship's radar horizon. If the ship has no radar, a height of 15 feet is entered. The combined radar horizons, maximum theoretical radar range of the raider's radar, and the actual range are compared. If the target is within both the radar horizon and the maximum radar range, the go/nogo flag is set to zero. If either test fails, the flag is set to one and the subroutine exits.

22. SUBROUTINE TMDASM

This subroutine determines if the target, or other unit in question, will enter within a certain input range of a BLUE unit, and if so, at what time will it enter and leave. TMDASM is called by SUBE1, SUBE2, and TIMMY. TMDASM in turn calls GETIMX on entry and exit if X(55) is set.

TMDASM begins by determining the range from the reference ship to the target unit. If this range is less than or equal to the input range, the time of entry is considered to be the input time. If the range to the target unit is greater than the input range, TMDASM determines the slope of a line representing target unit movement. Using this and the present target unit position as a reference point, TMDASM forms the line equation. This equation and the equation for a circle with radius equal to the input range are solved simultaneously to determine the points of intersection. This is done by substituting the line equation into the circle equation and solving the quadratic equation. If the roots are imaginary or equal, the entry is either not made or the length of stay is infinitely small. These cases are rejected as no solution. Upon finding two real roots, the subroutine determines which of the two points the target unit would reach first, and which one it would reach second. If the target unit is already further down its track than the exit point, no entry is indicated. Otherwise the time of leaving the circle is determined and, if the target unit was not already inside the circle, the time of entering.

23. SUBROUTINE TMDBOM

This subroutine determines when the raider in question will reach a given range from the force center, position (0,0). TMDBOM is called by MAIN, and JULIE. TMDBOM in turn calls GETIMX on entry and exit if X(55) is set.

TMDBOM proceeds in the same way as TMDASM except that the reference position, center of the range circle, is always force center instead of a firing ship. TMDBOM only computes the time that the raider will cross a given range. It neglects the departure time.

24. SUBROUTINE ZLNKA

Subroutine ZLNKA is a copy of the subroutine SHSORT, mentioned below, as it existed on 1 February 1975. ZLNKA inputs a vector of real numbers and an ordered vector of integers. ZLNKA reorders the real vector from smallest to largest and reorders the integer vector to the same order as the real vector. ZLNKA is called by TIMMY.

25. SUBROUTINE TJSORT

Subroutine TJSORT is a modification of the subroutine SHSORT which is available from the Naval Postgraduate School Computer library. TJSORT is called by SUBE2, and BIDET. This subroutine inputs a vector of real numbers and rearranges them from smallest to largest.

26. SUBROUTINE LOCTIM

LOCTIM computes the raider position at time T. It is called by MAIN, SUBE1, SUBE2, SUBE3, JAMM, BIDET, TIMMY, and PRIOR. LOCTIM in turn calls GETIMX on entry and exit if X(55) is set.

LOCTIM first determines raider velocity and the time of the raider position stored in the RAID table. The distance the raider travels between the present time and the stored time (DL) is computed. If the velocity is zero, present target position is set to the initial position and the program exits. The distance between the stored position and the end of game position (D) is determined and the ratio DL/D is computed. The X,Y position at the time desired is determined by:

$$XP = XZ - \Delta X * DT$$

$$YP = YZ - \Delta Y * DT$$

where

XP is the X position at the time of interest

YP is the Y position at the time of interest

XZ is the stored X position

YZ is the stored Y position

ΔX is the distance between XZ and the end of game position

ΔY is the distance between YZ and the end of game position

DT is the ratio DL/D

If the input flag IND has been set to 5, the new time and position are stored in the RAID table, otherwise the subroutine exits.

27. SUBROUTINE ASMTIM

ASMTIM computes the ASM/SSM position at time T. It is called by SUBE3, TIMMY, and PRIOR. ASMTIM calls GETIMX on entry and exit if X(55) is set.

The logic of ASMTIM is identical to that of LOCTIM but the definition of variables has been changed.

XZ becomes the ASM/SSM X launch coordinate

YZ becomes the ASM/SSM Y launch coordinate

ΔX becomes the distance between the launch position and the X coordinate of the target ship

ΔY becomes the distance between the launch position and the Y coordinate of the target ship

The ASM/SSM position is now computed in the same manner as in LOCTIM and the subroutine exits. The positions are not saved by ASMTIM.

28. SUBROUTINE RANDOM

Subroutine RANDOM is a generator of Uniform (0.0, 1.0) random numbers. It was programmed by Gerald P. Learmouth, of the W.R. Church Computer Center, Naval Postgraduate School. The following is taken from the library description of the subroutine:

> "The basic generator is a Lehmer congruential of the form:
>
> X(N) = A*X(N-1) MOD (P)
>
> where A = 7**5 = 16807 and P = (2**31)-1. The resulting X(N)'s are uniformly distributed random integers between 1 and P. The uniform REAL*4 numbers are formed by right-shifting the integer X(N) and appending a proper floating point exponent to form a number between 0.0 and 1.0."

29. SUBROUTINE HISTG

Subroutine HISTG is found in the subroutine library of the Naval Postgraduate School subroutine library. A copy of HISTG has been included at the end of the program. The subroutine is used if the user wants a statistical display of the number of hits a certain specified BLUE unit will take. Also provided is a statistical display of the time interval over which the RED missiles arrive, and one of the hits per minute. A histogram of the selected parameter is provided in all cases. HISTG is called by MAIN just prior to run completion if X(85) has been set and the conditions detailed in section V.B have been met.

30. SUBROUTINE RAIDIS

This subroutine provides a plot of the raider tracks from their initial position to launch position. The maximum size of the plot is 800 nm from force center. In the case where a raider does not launch weapons, the 30 minute game time position is used as the terminal point of the track. If the launch or 30 minute position is more than 800 nm from force center, a label of "no launch" is displayed at the raider's initial position.

31. SUBROUTINE DISPL

DISPL is similar to RAIDIS except that the BLUE unit positions are plotted and they must be within 200 nm of force center. A 100 nm range circle is included in the display.

32. SUBROUTINE SETIMX

This subroutine sets the internal clock to zero. The entry GETIMX gives the internal clock time when called.

33. FUNCTION RADIAN

The function RADIAN converts degrees to radians. It is called by MAIN, JULIE, and TIMMY. The conversion is done with:

$$RADIAN = RD * 0.017453293$$

where RADIAN is the output angle in radians and RD is the input angle in degrees.

APPENDIX C

RADAR DETECTION RANGE INPUTS

This appendix provides the equations used to determine the β and α inputs for the individual radar classes.

1. CLEAR ENVIRONMENT

β is the range at which a one square meter target can be detected in a non-jamming environment. It is a constant of the radar system and in the monostatic case provides the range of detection for the radar by the relation:

Range = $\beta(\sigma)^{\frac{1}{4}}$ where σ is the target's radar cross section.

The general equation for β is:

$$\beta = [(\frac{P_t}{P_m})\frac{G^2\lambda^2}{(4\pi)^3}]^{\frac{1}{4}}$$

where P_t is the power of the transmitter in watts; G is the antenna gain coefficient; λ is the radar wave length in meters; and P_m is the minimum detectable signal of the radar with appropriate consideration for probability of detection and propagation losses. If the above units are used in calculating β, the result will be a detection range in meters which must be converted to nautical miles for use in the simulation. Values of β, in nautical miles for a one square meter target, are reported in Ref. 9 for standard U.S. Navy radar systems.

In the case of the bistatic system, the equation for β becomes

$$\beta = [(\frac{P_t}{P_m}) \frac{G_t G_r \lambda^2}{(4\pi)^3}]^{\frac{1}{4}}$$

where the possibility of different gains of the transmitter and receiver must be considered and the propagation losses in P_m must take into consideration the differences in the transmitter to target path and the target to receiver path. Additionally, in the bistatic situation, the detection range is not only a function of the range from the receiver (R_r) to the target but it is also a factor of the range from the transmitter (R_t) to the target. Thus the bistatic range equation becomes

$$R_t R_r = \beta^2 \sigma^{\frac{1}{2}}$$

The monostatic radar cross section provides a suitable estimate for the bistatic radar cross section [Ref. 10, p. 592].

2. JAMMING ENVIRONMENT

α is the range at which a one square meter target can be detected in a jamming level of one watt/mhz. The burn through range for a monostatic radar in a multiple-standoff jamming environment is:

$$R_{bt} = \alpha^{\frac{1}{2}} (\sigma/SJP)^{\frac{1}{4}}$$

where σ is the target's radar cross section and SJP is the sum of the jamming power arriving at the radar. The jamming power from an individual jammer on the radar's frequency is

a function of the power of the jammer; the side-lobe/main beam relationships between the jammer and the radar; and the square of the range from the jammer to the radar. The equation is:

$$SJP = \sum_i C_i JP_i / R_i^2$$

where C_i is the side-lobe coefficient for jammer i and the radar; JP_i is the jamming power of jammer i on the radar's frequency; and R_i is the range from the jammer to the radar. α is found by the relation:

$$\alpha = \left(\frac{P_t G_t^{\frac{1}{2}} G_r^{\frac{1}{2}}}{4\pi B_n (S/J)}\right)^{\frac{1}{2}}$$

where P_t is the power of the transmitter; G is the gain of the radar (In bistatic systems G is the square root of the product of the transmitter and receiver gains.); B_n is the receiver bandwidth of the radar; and S/J is the signal to jamming ratio for the desired probability of detection and appropriate propagation losses. In the bistatic range equation in a multiple standoff jamming environment, the burn through range is found in a manner similar to the clear environment to be

$$R_{bt} R_t = \alpha(\sigma/SJP)^{\frac{1}{2}}$$

where R_{bt} is the burn through range, R_t is the range from the bistatic transmitter to the target and the remaining factors are as defined above.

APPENDIX D

PROGRAM ARRAY LISTING

This appendix provides an alphabetical listing of the principal arrays used in the computer program. The listing contains the values of the arrays for the indicated array arguments. The arguments for the arrays are specified in the heading of their respective listing. The dimensions of the individual arrays are stated in the COMMON statement at the beginning of each subroutine.

ASMT (I,J)

The ASMT array contains data concerning the RED missiles.

I	AMS/SSM launch sequence number
J=1	ASM/SSM status code as follows: 0 = Launch failure 1 = Successful launch 2 = Killed by SAM 3 = Inflight failure 4 = Hit target ship 5 = Launch platform shot down or sunk prior to launch
J=2	Time of impact on target ship
J=3	Raid number of launch platform
J=4	Target ship number
J=5	Time of launch
J=6	Weapon class
J=7	X coordinate of launch position
J=8	Y coordinate of launch position

CHANEL (I,J,K,L)

An array used to keep track of which channels are busy.

I	Ship number
J	System number
K	Director number
L	Channel number 0 = Free 1 = Busy

JACK (I,J)

This array stores the engagement and detection statistics for individual ships.

I	Ship number
J=1	Chances to engage. The number of targets that will enter within the maximum missile range of the ship
J=2	Number of engagements
J=3	Number of targets destroyed
J=4	The number of raiders that will enter the missile envelope.
J=5	The number of raiders that will enter the envelope and are detected
J=6	The number of ASM/SSM that will enter the envelope
J=7	The number of ASM/SSM that will enter the envelope and are detected

NADAR (I,J)

This array indicates the operational status of the onboard BLUE equipment.

I	Ship number

J=1 Search radar number 1

0 = down
1 = up

J=2 Search radar number 2

J=3 Search radar number 3

J=4 Battery one, fire control radar number 1

0 = down
1 = operational normal mode
2 = no director needed for missile
3 = operational in horizon scan mode

J=5 Battery one, fire control radar 2

J=6 Battery one, fire control radar 3

J=7 Battery two, fire control radar 1

J=8 Battery two, fire control radar 2

J=9 Battery two, fire control radar 3

J=10 Battery three, fire control radar 1

J=11 Battery three, fire control radar 2

J=12 Battery three, fire control radar 3

J=13 Battery four, fire control radar 1

J=14 Battery four, fire control radar 2

J=15 Battery four, fire control radar 3

J=16 Launcher for battery one

0 = non operational
1 = operational

J=17 Launcher for battery two

J=18 Launcher for battery three

J=19 Launcher for battery four

RAID (I,J)

This array stores information on the raider's location and weapons.

I	Raider number
J=1	X vector starting index of the raid class
J=2	Time that raid was at position indicated in J=3,4
J=3	X coordinate at time T
J=4	Y coordinate at time T
J=5	X coordinate at end of game
J=6	Y coordinate at end of game
J=7	X coordinate at launch if the raider has weapons and can reach the launch position, otherwise the X coordinate at end of game.
J=8	Y coordinate at launch, same as J=7
J=9	Raider altitude in feet
J=10	Raider's radar horizon
J=11	Weapon class of raider's longest range weapon
J=12	Total number of weapons assigned
J=13	Status 0 = destroyed or sunk N = number of hits the raider may take until destroyed
J=14	X coordinate of raider at end of game or X coordinate of target ship for ASM/SSM launched by raider I
J=15	Y coordinate comparable to J=14
J=16	Time raider will reach second launch point if it is carrying two types of missiles
J=17	Time the raider was destroyed

SAMASM (I,J)

This array contains information covering the BLUE missile launch, target, engagement outcome, and probability of kill.

I	BLUE salvo number
J=1	Target number, 1-90 are raiders, 91-191 are ASM/SSM
J=2	Ship number followed by system number
J=3	Director number followed by channel number
J=4	Time of launch
J=5	Engagement outcome. Negative number indicates an overkill, zero a failure, and a positive number a successful shot.
J=6	Time the channel will be free for reassignment
J=7	Single shot probability of kill

SHIP (I,J)

The SHIP array contains information concerning the BLUE units.

I	Ship number
J=1	Ship class
J=2	X coordinate of ship position
J=3	Y coordinate of ship position
J=4	Number of hits ship can receive until declared out of action. If 0, ship is out of action.
J=5	Ship class starting index
J=6	Missile status code 0 = no missile capability 1 = missile capability

SMAT (I,J)

The SMAT array lists the results of the SAM firings.

I	SAM number
J=1	SAM class index
J=2	Firing ship number
J=3	Number of missiles remaining in the battery firing the SAM
J=4	Time fire control radar channel 1 free
J=5	Time fire control radar channel 2 free
J=6	Time fire control radar channel 3 free
J=7	Time fire control radar channel 4 free
J=8	Time fire control radar channel 5 free
J=9	Time fire control radar channel 6 free
J=10	Number of SAMs in the salvo

STATS (I,J)

The STATS array is used to compile statistics concerning the BLUE units.

I	Ship number
J=1	Sum of the detection ranges on raiders
J=2	Sum of the detection ranges on missiles

APPENDIX E

GLOSSARY FOR PROGRAM VARIABLES

1. MAIN PROGRAM

ALFA	REAL*8 variable used for conversion of degrees to radians.
AMF	Small real constant used for conversion from floating point variables to integer variables.
ASMT	The table containing RED ASM/SSM launch and targeting information.
BWJ	Beam width of the jammer.
BWR	Beam width of the radar receiver.
HISA	Vector used to store data for use with subroutine HISTG.
HISO	Vector used to store data for use with subroutine HISTG.
HISTG	Subroutine in the NPS computer library that provides a histogram display of an input vector.
HISX	Vector used to store data for use with subroutine HISTG.
IBAT	An array used to keep track of the number of missiles remaining in each missile battery of a BLUE unit.
IFAG	Integer constant containing the number of RED missiles engaged by the BLUE fleet.
IFBG	Integer constant containing the number of RED raiders engaged by the BLUE fleet.
IHIT	Vector containing the number of hits received by each BLUE unit.
IIF	The number of RED missiles that failed in flight.
IKS	The number of RED missiles shot down by BLUE SAMs.
ILF	The number of RED missiles that failed when launched.

ILS	The number of RED missiles that were in flight at the end of the iteration.
IMF	The number of RED missiles destroyed when the launching aircraft or ship was destroyed.
IMK	The number of RED missiles destroyed by SAMs over all iterations.
IMM	The number of RED missiles destroyed prior to launch over all iterations.
INSECT	The original seed value used with the random number generator. Used to reproduce the random number chain if X(54) is set to 1.
IRT	The starting address in the X vector for the next five input quantities.
ISAG	An array containing the number of RED missiles first engaged by each BLUE ship.
ISBG	An array containing the number of RED raiders first engaged by each BLUE ship.
ITS	The number of RED missiles that impacted on their target.
JACK	The array containing the BLUE ship detection and engagement counters.
KOUNT	The iteration number.
MARY	The vector containing the data for the hit frequency histogram.
NADAR	The array that stores the BLUE radar and missile system availability for each iteration.
NASM	The number of ASM/SSMs.
ND	Index used to convert true bearings to cartesian bearings.
NI	The number of iterations to be performed.
NMIF	The number of missiles in the BLUE fleet.
NR	The number of armed and unarmed RED raiders.
NRTGT	The vector containing the RED units target list assignment.

NS	The number of BLUE ships.
NSAM	The number of BLUE missile salvos fired.
PLIST	The array containing the target lists.
RAID	The table containing the RED raider position and weapon information.
RAT	REAL*8 variable used to convert degrees to radians.
RXATA	Dummy array used to read in data and fill the X vector.
SAMASM	The array containing the BLUE missile RED target engagement information.
SETIMX	The subroutine that sets the internal clock if X(55) is set to 1.
SHIP	The table containing the BLUE ship position information.
SMAT	The table containing the BLUE missile battery engagement data.
STATS	The array containing the BLUE unit detection ranges.
T	Time.

2. SUBROUTINE EFFECT

IUNIT	The code containing the units involved in playing the next event.
NEXTEV	The next event type.
TIME	The time the next event is to be played.
TIMES	The internal clock time used for entry and exit if X(55) is set.

3. SUBROUTINE JULIE

BNG	A REAL*8 variable used to convert degrees to radians.
CHANEL	The array that keeps track of which BLUE missile channels are busy.
IA	The X vector address of the fire control radar class number.

IBAT	The array that keeps track of the number of BLUE missiles remaining in each battery.
IC	The radar class of the fire control radar associated with the number one director of the indicated BLUE missile battery.
IFAG	Integer constant containing the number of RED missiles engaged by the BLUE fleet.
IFBG	Integer constant containing the number of RED raiders engaged by the BLUE fleet.
IFIRST	Flag used for checking a target's priority.
IFLASK	Flag used to set the time by which all RED raiders must reach their launch point in order to launch their missiles.
IFOG	Flag to indicate a) horizon search mode, and b) the system has a launcher that is operable.
IGAGE	A vector that keeps track of which targets have been engaged by BLUE missiles.
IHIT	A vector that keeps track of how many hits each BLUE unit has taken.
IJ	The ship class starting index in the X vector.
IOR	The raid class starting index in the X vector.
IP	Missile system class number.
IS	The ship class starting index in the X vector.
ISAG	Integer constant to determine how many RED missiles the ship was the first to engage.
ISBG	Integer constant to determine how many RED raiders the ship was the first to engage.
IT	Search radar class number.
ITEMS	The number of events that have been retrieved from the events list.
IVENTS	The array containing the events list.
JACK	The array containing the ship detection and engagement statistics.

JAM	The vector that keeps track of the number of jammers operating on a given radar frequency band.
KFOG	Flag to indicate that a search radar is available.
LOVER	The number of events in the events list.
MAMBAT	The number of missile batteries available to the BLUE force.
MISLFT	The array that keeps track of how many missiles a RED raider has left on board.
NADAR	The array that keeps track of the operational mode of the BLUE equipment.
NASM	The number of RED missiles.
NONO	The array that keeps track of engageability of a RED unit or missile with respect to each BLUE unit.
NR	The number of armed and unarmed RED raiders.
NS	The number of BLUE units.
NSAM	The number of BLUE missile salvos.
PROB	The probability that a given piece of equipment is operational.
RAID	The table with the raider location and weapon information.
RELOAD	The array that stores the time the launcher will be reloaded by after a missile firing.
RGE	The launch range of the longest ranged missile carried by each raider.
SHIP	The table containing the ship position information.
SMAT	The table with the BLUE missile system launch information.
STATS	The table of BLUE detection ranges.
TGTAV	The table that tells when a target will be available for engagement by another BLUE unit.

4. SUBROUTINE EVENT

ICODE	The participating units-event type code that is stored in the events list.
ID	The event type.
IT	The time of the event converted to the integer format used to store it in the events list.
ITB	Used to determine where in the events list the next event to be stored should go.
ITEMS	The number of events retrieved.
ITIM	The time as stored in the events list.
ITM	The time as stored in the events list.
IUNIT	The units involved in playing the next event.
IVENTS	The events list.
IVET	The participating units as stored in the events list.
LOVER	The number of events stored in the events list.
NEXTEV	The next event type.
NUMBER	The code for the participating units.
T	The time of the event.
TIME	The time of the event.

5. SUBROUTINE REMOVE

IUNYT	The code stored in the events list of the event to be removed from the events list.
IVENTS	The events list.
LOVER	The number of items in the events list.

6. SUBROUTINE TARGET

IFIRST	The flag that indicates that the counter has been zeroed.
IT	The game time in events list code.

IUNIT	The code of the event to be compared by PRIOR.
IVENTS	The events list.
MORE	The flag indicating that there is an event with the same playing time and of type three.
NPGS	The counter that is used as an index in searching the events list.
TYME	Present game time.

7. SUBROUTINE SUBE1

ALT	The raider's altitude.
AREA	The fourth root of the raider's radar cross section.
DELR	The detection delay.
FCRH	The radar horizon of the fire control radar.
FRG	The minimum of the clear environment detection range, the radar horizon, and the radar's theoretical maximum detection range.
HFCSR	The radar horizon of the fire control radar.
HORZ	The combined radar horizons of the radar and the target.
HRAG	The combined radar horizons of the radar and the target.
HRFC	The combined radar horizons of the radar and the target.
HSFR	The minimum of the clear environment detection range, the radar horizons, and the maximum theoretical detection range.
HT	The height of the fire control radar antenna.
IA	Used to check the class numbers of the various systems.
IC	Missile system class number.
ICH	Used to enter the NADAR table.
ICL	Fire control radar class number.

ICPA	Flag telling whether the target will come within the maximum detection range.
IFA	Integer to store the radar number.
IFC	Integer to store the battery number.
IFCR	Fire control radar class number.
IF	Radar frequency band.
IR	The raid number.
ISI	The ship class starting index in the X vector.
JACK	The table of engagements and detections.
JAM	The table that keeps track of how many jammers there are on each radar frequency band.
JAMM	The subroutine for determining the detection range of a monostatic radar in a jamming environment.
JCPA	The flag that tells whether or not the target will come within the detection range.
JFOG	The flag that tells whether or not this is the second bistatic detection zone.
KEY	The type of probability distribution associated with this unit's time delays.
KFLAG	Flag that says that this unit has a search radar that is operational.
LCPA	Flag that tells whether or not a target will close to within the detection range.
MFOG	Counter giving the number of second bistatic detection zones to be processed.
MJL	Index for table lookup.
MTY	Missile system class number.
NADAR	The table containing the equipment availability.
NASA	The flag indicating that raider is an aircraft.
NASM	The number of ASM/SSM launched or destroyed.
NB	The battery number.
ND	The number of bistatic detection zones.

NF	The director number.
NFOG	Flag telling whether or not there are any more bistatic detection zones to check.
NJ	The number of jamming raiders.
NONO	The table that contains the reason for non-engageability.
NSR	The search radar index.
NSURF	Flag that says that this ship has a surface to surface missile system.
PROB	Probability of acquisition.
RAGJ	Detection range in a jamming environment.
RAID	The table with raider location and weapon information.
RCPS	Range at CPA squared.
REACT	Subroutine for determining reaction time delays.
RFCJ	Fire control radar detection range in the jamming environment.
RG	The minimum of the clear environment detection range, the radar horizon range, and the theoretical maximum detection range.
RGE	Detection range.
RGF	Jamming environment detection range.
RGFC	Detection range of the fire control radar.
RGI	Detection range in a jamming environment.
RGIA	Storage for second bistatic detection range.
RGIB	Storage for second bistatic detection range.
RGIC	Storage for second bistatic detection range.
RGM	Missile range.
RIP	The maximum detection range, or present target position, whichever is smaller.
RRFC	Clear environment fire control radar detection range.

RRH	Radar horizon of the search radar.
R2	The detection range in the second bistatic detection zone.
SALT	The radar horizon of the raider.
SAMVEL	The BLUE missile's speed.
SHIP	The table with the ship position information.
SIGMA	The raider radar cross section.
SRAG	Missile range.
SRFC	Fire control radar clear environment detection range.
STATS	Ship's detection range storage.
SVEL	Missile speed.
TD	Time raider will close to the given range.
TDES	The designation time delay.
TDET	The time of detection.
TD2	The time of detection in the second bistatic detection zone.
TFIR	The last time to fire.
TFIRE	The firing time delay.
TFR	Time the target will close to fire control acquisition range.
THR	Theoretical radar maximum detection range.
THSCAN	Horizon scan detection delay.
TI	Time the target will close to the given range.
TIME	Present game time.
TIML	Time the target will go beyond the given range.
TIMLA	Storage for lose detection time.
TIMLB	Storage for lose detection time.
TIMLC	Storage for lose detection time.

TIML2	Time of lose detection in the second bistatic detection zone.
TLS	Last time to fire.
TRGE	Time of detection.
TSHOOT	Time of launch.
TSR	Total reaction delay.
TTA	Storage for detection time in second detection zone.
TTB	Storage for detection time in second detection zone.
TTC	Storage for detection time in second detection zone.
TWDS	Reaction time delay for weapons designation equipment.
VEL	Raider speed.
XCP	The X coordinate of the CPA.
YCP	The Y coordinate of the CPA.

8. <u>SUBROUTINE SUBE2</u>

ALT	Altitude of the RED ASM/SSM during flight in feet.
ALTN2	Altitude of the RED ASM/SSM squared in miles.
AREA	The fourth root of the radar cross sectional area of the RED missile.
ASMT	The table containing RED missile launch and targeting information.
DELR	The detection time delay.
DELTAX	The distance in the X direction between the target ship and the ASM/SSM launch point.
DELTAY	The distance in the Y direction between the target ship and the ASM/SSM launch point.
DIST	The three dimensional distance from the ASM/SSM launch point to the target ship. This distance assumes launch at cruising altitude.
HORZ	The combined radar horizons of the firing ship and the RED missile.

HRAG	The combined radar horizons of the firing ship and the RED missile.
HT	The BLUE radar antenna height.
IA	Fire control radar class number.
IC	The BLUE missile system class number.
ICL	Fire control radar class number.
ICOP	Constant for X vector entry set by SUBE2.
ICPA	Flag telling whether or not a RED missile will come within the detection range.
IDP	Index counter used to make up the RED raider's temporary target list.
IFA	The director number.
IFC	The battery number.
IFCR	BLUE missile system class number.
IFLAG	Flag indicating RED unit is firing a two missile salvo.
IFLASK	Flag indicating the first air launch has occurred, set TMAX.
IHIT	Table of hits taken by BLUE ships.
IJ	Raider class number.
IJI	Radar frequency band.
IOU	Target ship number.
IPQ	Target hit number.
IR	Raider number.
ISI	Ship class starting index in the X vector.
JACK	Ship detection and engagement table.
JAM	Table that keeps track of the number of jammers on the radar frequency bands.
JAMM	Subroutine to determine monostatic radar detection ranges in a jamming environment.

JFLAG	Flag indicating that there are more second bistatic detection zones to evaluate.
JFOG	Flag indicating that there were two bistatic detection zones.
KATHY	Flag indicating that a second type ASM/SSM is being processed.
KEY	Type of probability distribution to be used in computing the reaction time delay.
KFLAG	Flag indicating BLUE unit has an operational search radar.
KING	Flag for one or two missile salvos.
KQED	Flag indicating whether or not raid could target a particular BLUE unit.
LNUM	The class number of the raider's long range missiles.
MARIE	Number of hits required to put the BLUE unit out of action.
MFOG	Counter indicating the number of second bistatic detection zones.
MISLFT	Array to indicate the number of ASM/SSM left on board a raider.
NADAR	The array that stores BLUE equipment operability.
NASM	The number of ASM/SSMs processed.
ND	The number of bistatic detection zones.
NEXT	Flag indicating the short range RED missiles.
NFOG	Flag indicating there are more detection zones to process.
NJ	The number of jammers.
NMIS	The number of ASM/SSM of this type to be launched.
NONE	The index used to draw random numbers from the random number vector.
NONO	The array specifying the target-firing ship relationship.
NOW	The type missile being processed now.

NR	The number of raiders.
NRTGT	The target list assignments.
NS	The number of BLUE units.
NTOT	The total number of ASM/SSM on board.
PLIST	The target lists.
PROB	The probability of acquisition in horizon scan mode of operation.
QRT	The vector of (0,1) random numbers used to determine missile launch times.
RAGJ	The search radar detection range in a jamming environment.
RAID	The table with the raider location and weapon information.
RCPS	The slant range to CPA.
RELI	The RED missile's inflight reliability.
RFCJ	Detection range of fire control radar in a jamming environment.
RG	The minimum of the clear, jamming, and theoretical detection ranges.
RGE	Detection range.
RGF	Detection range.
RGFC	Fire control radar detection range.
RGI	Detection range.
RGIA	Storage for secondary bistatic detection range.
RGIB	Storage for secondary bistatic detection range.
RGIC	Storage for secondary bistatic detection range.
RGM	BLUE missile range.
RGS	Detection range squared.
RIP	Minimum of present range and detection range.
RRFC	Horizon search clear environment detection range.

RRH	Radar horizon.
RT	Cumulative probability of targeting this target or one previous.
R2	Second bistatic detection range.
SALT	The radar horizon of the RED weapon.
SAMVEL	BLUE missile speed.
SHIP	The table containing ship position information.
SIGMA	The RED weapon radar cross sectional area.
SPD	The RED weapon speed.
SRAG	Search radar detection range in a clear environment.
SRFC	Fire control radar detection range in a clear environment.
SRGE	BLUE ship missile range.
STATS	Array containing the sum of a ship's detection ranges.
SVEL	BLUE missile speed.
TAC	Acquisition time delay.
TD	Time of detection.
TDES	Designation time delay.
TDET	Time of detection.
TD2	Time of detection in the second bistatic detection zone.
TFIR	Last time to fire based on search radar range and maximum range missile.
TFIRE	Firing time delay.
TFR	Time target will come within the fire control detection range.
THR	Maximum theoretical radar range.
THSCAN	Reaction time delay for horizon scan mode of operation.

TI	Time target will come within the search radar detection range.
TIFA	Time target will come within the horizon scan detection range.
TIME	Present game time.
TIMF	Time target will exit the fire control radar detection range.
TIML	Time the target will go beyond the search radar detection range.
TIMLA	Storage for second bistatic detection zone loss of target time.
TIMLB	Storage for second bistatic detection zone loss of target time.
TIMLC	Storage for second bistatic detection zone loss of target time.
TIML2	Time target will go beyond detection range in the second bistatic detection zone.
TINT	The time interval over which all missiles must be launched.
TLS	Last time to fire based on fire control radar range.
TM	Proposed RED missile launch time.
TMAX	Time limit on launch of RED missiles.
TRGE	a) Hazard zone range squared, b) time of detection.
TSHOOT	Time of proposed BLUE missile launch.
TSR	Total reaction time delay.
TTA	Storage for second detection zone detection time.
TTARG	The temporary target list.
TTB	Storage for second detection zone detection time.
TTC	Storage for second detection zone detection time.
TWDS	Delay for weapons direction equipment processing.
TX	Time between RED missile launchings.
VEL	RED missile speed.

XCPA	CPA position in the X direction.
YCPA	CPA position in the Y direction.
Z	(0,1) random number.

9. SUBROUTINE SUBE3

ASMT	The table containing the RED missile launch and targeting information.
CHANEL	The array that indicates which system channels are in use.
EBTJR	The Y coordinate of CPA.
FT	BLUE missile flight time.
IBAT	Array giving the number of BLUE missiles available by battery.
ICOT	Flag indicating channel assigned.
IP	Ship class starting index in the X vector.
IU	Input code giving target, ship, system, and director information.
JAPL	A channel number.
JULIA	RED missile number for table lookup.
K	Firing ship number.
KA	Target ship number.
M	Number of original target.
MFOG	Flag used to check director scheduling.
M1	Target number after searching PRIOR.
NADAR	Array to check launcher operability.
NB	Director number.
NC	Channel number.
NCH	Number of channels associated with this radar.
NC1	Channel number.
NMS	Missile system number.

NSAM	BLUE salvo number.
PROB	Probability of kill.
RAID	Table of raider positions.
REASON	Code for non-engageability.
RELOAD	Table that tells if the launcher is loaded.
RGE	Systems maximum range.
RJL	The X coordinate of CPA.
RLT	Launcher reload time.
SAMASM	The table of BLUE missile and RED target engagement data.
SHIP	Table of ship positions.
SMAT	Table of BLUE missile system data.
TCF	Dummy vector for storing the times the channels will be free for other use.
TFT	Time director first available for channel use.
TF	Time director needed.
TGTAV	Time target available for engagement by another unit.
TIM	Time channel free.
TIME	Present game time.
TL	Time director no longer needed.
TT	Time director needed for homing.
XP	Present target X coordinate.
YP	Present target Y coordinate.

10. SUBROUTINE SUBE4

ID	Used as a class indicator, i.e. ASM type, or as an integer constant, i.e. number of hits to sink the target ship.
IHIT	The table containing the number of hits sustained thus far in the game.

IU	The input code containing the RED missile number and the BLUE target ship number.
K	The target ship number.
NAM	The RED ASM/SSM number for table lookup.
NAS	The RED ASM/SSM number in the input code.
PB	The probability of successful flight for the RED missile. Also used in determining the input and output time of the subroutine if X(55) is set.

11. SUBROUTINE SUBE5

ASMT	The table containing the data on the RED missile engagement.
CHANEL	The table that keeps track of which BLUE missile channels are being used.
ID	An integer constant used for the starting address in the X-array of the BLUE firing ship's class inputs. Also used as the number of RED ASM/SSMs launched up to the present game time.
IFAG	Integer constant that totals up the number of RED missiles engaged by the BLUE fleet.
IFBG	Integer constant that totals up the number of RED raiders engaged by the BLUE fleet.
IGAGE	Integer constant that keeps track of which targets have been engaged.
IP	Radar class of the BLUE fire control radar associated with the engagement.
IQ	BLUE missile system class number.
ISAG	Integer constant that totals up the number of RED missiles first engaged by this firing ship.
ISBG	Integer constant that totals up the number of RED raiders first engaged by this firing ship.
JACK	The table that keeps track of the number of missiles and raiders engaged by the firing ship.
JAM	The table that totals up the number of jammers operating on a particular radar frequency band.

JFK	Integer used in table lookup.
K	The BLUE firing ship.
KEY	As used in the statement -- CALL REACT (KEY,4,TA) -- where 4 is the type of delay, KEY is the class of the particular distribution within the type, and TA is the delay.
M	The BLUE salvo number.
MISLFT	The table that keeps track of the number of missiles remaining on board the RED raider.
N	The number of missiles in the BLUE salvo.
NA	The RED ASM/SSM number for table lookup.
NASM	The number of RED ASM/SSMs processed thus far.
NB	The BLUE ship's director involved in the engagement.
NC	The channel number of the fire control system engaged in the intercept.
NDU	The starting address of the class associated with the raider involved in the intercept.
NMS	The number of the ship's missile system involved in the intercept.
NT	The target number, 1-90 for a raider, 91-190 for a RED missile.
NTOT	The number of missiles left on board the raider.
PB	The probability that the BLUE missile will receive the proper support during flight.
PROB	The overall probability of a successful intercept.
SAMASM	The table that keeps BLUE salvo information.
SMAT	The table that keeps BLUE system information.
TA	The time delay for target acquisition.
TF	The time delay for firing.
TK	The time delay for kill assessment.

12. SUBROUTINE SUBE6

CHANEL	The table that keeps track of which BLUE missile channels are being used.
K	The firing ship.
M	The input code containing the ship, system, director, and channel number to be released.
NB	The director number.
NC	The channel number.
NMS	The system number.
T	The input and output time for the subroutine, used if X(55) is set.

13. SUBROUTINE TIMMY

A	The cross range factor in the intercept contour.
ALPHA	The angle between the target flight path and the line of sight to the target.
ALT	The target altitude.
ASMT	The table containing the data on the RED missile engagement.
ASMTIM	Subroutine to determine RED missile position at a given time.
B	The downrange factor in the intercept contour.
BETA	The angle between the BLUE missile flight path and the target's direction of movement.
CS	The target course.
DELTA	The reciprocal of BETA.
DELTAX	Used for a) the X distance from the target ship to the RED missile, b) the present distance in the X direction from the firing ship to the target, and c) the distance in the X direction from the firing ship to the intercept point.
DELTAY	Same as DELTAX but in the Y direction.
DIS	Range to the intercept point.

DLT	Range to the intercept point.
DX	Distance in the X direction from the initial target position to the intercept point. Used if intercept point is over the firing ship.
DY	Distance in the Y direction from the initial target position to the intercept point. Used if the intercept point is directly over the firing ship.
EX	The exponent that defines the super ellipse of the intercept contour.
FT	BLUE missile flight time.
FZL	Left hand limit of the firing zone.
FZL1	Left hand limit of the second firing zone if a second exists.
FZR	Right hand limit of the firing zone.
FZR1	Right hand limit of the second firing zone.
GAMMA	Angle between the BLUE missile flight path and the line of sight to the target at launch.
GSINE	The sine of GAMMA.
ID	RED missile type.
IND	Flag indicating the feasibility of the intercept.
IR	RED missile's launching raid number.
JOAN	RED missile's target ship number.
JULIA	RED missile number for table lookup.
K	Firing ship number.
KL	Starting index for the BLUE missile class.
KR	Raider class number.
LOCTIM	Subroutine for determining raider position at a desired time.
M	Target number.
NMS	BLUE missile system number.
NS	The number of ships in the BLUE force.

PHI	The BLUE firing bearing.
PHI1	The angle of axis rotation for intercept contour engagement evaluation.
PI	3.141592654.
PIZ	The hazard range squared.
PK	The single shot kill probability.
PM	The probability of successful launch.
PROB	PK times PM.
RADIAN	A function for converting angles in degrees to angles in radians.
RAID	The table with the raider position and weapon information.
RAT	A REAL*8 variable for use with RADIAN.
REASON	A code to indicate the reason for non-engagement.
RMAX	The maximum range of the BLUE missile.
RMIN	The minimum range of the BLUE missile.
RUTH	Target altitude in miles.
RXATA	Dummy vector use to determine the firing zone.
SEEK	Y intercept of the intercept contour seeker limitation approximation.
SLOPE	The slope of the line that approximates the seeker look limitation.
SSPD	Speed of the BLUE missile.
THETA	The angle, measured in the normal X,Y plane, of the line from the firing ship to the present target position.
TH1	The reciprocal of THETA.
TIME	The time of the proposed missile launch.
TKIL	The time of intercept.
TX	The time the target will enter the maximum missile range for this system.

TXL	The time the target will depart the maximum missile range for this system.
VEL	The speed of the target.
XI	The X coordinate of the intercept.
XIP	The X intercept coordinate after axis rotation and translation.
XIS	The X intercept coordinate after axis translation.
XP	The X coordinate of the present target position.
XT	The end of game X coordinate for the target if it is a raider, or the target ship coordinate if the BLUE missile's target is a RED ASM/SSM.
XW	The initial position of the target in the X direction.
YI	The Y coordinate of the intercept point.
YIP	The Y intercept coordinate after axis rotation and translation.
YIS	The Y intercept coordinate after axis translation.
YP	The Y coordinate of the present target position.
YT	The end of game Y coordinate for the target.
YW	The Y coordinate of the initial target position.
ZLNKA	A sorting subroutine.

14. SUBROUTINE JAMM

AREA	Fourth root of target's radar cross section.
COFF	Jammer's main beam/side-lobe coefficient.
DELX	Target's track change in X direction minus 0.1 nm.
DELY	Target's track change in Y direction minus 0.1 nm.
HJBW	One-half jammer beam width in radians.
HRBW	One-half radar beam width in radians.
ITS	Target ship number.
JJTBR	Bearing from jammer to the jamming target.

JRBRG	Bearing from the jammer to the detecting radar.
LJBW	Left bearing of the jamming beam.
LTBRG	Left bearing of the detecting radar's beam while pointed at the target.
NASM	Number of the ASM.
NR	Number of raiders.
PJ	Power of the jammer on the detecting radar's frequency.
RCOF	Detecting radar's side-lobe coefficient.
RCOFF	Detecting radar's side-lobe coefficient for specific jammer-target-radar geometry.
RCPS	Range to track CPA squared.
RJBRG	Detecting radar to jammer bearing.
RJBW	Right bearing of jammer beam.
RJHS	Detecting radar-jammer horizon squared.
RRJS	Range from the detecting radar to the jammer squared.
RTBRG	Right bearing of the detecting radar's beam width while pointed at the target.
SUMJP	Sum of the jamming power arriving at the detecting radar.
TBRG	Target bearing from the detecting radar.
TIMC	Time constant used to adjust midpoint time. Base on target's launch time or game time of target's initial position.
TIMI	Time target is at its midpoint in detecting radar's detection envelope.
TIMX	Time target is at the X coordinate of its midpoint in the detecting radar's detection envelope.
TIMY	Time target is at the Y coordinate of its midpoint in the detecting radar's detection envelope.
VD	Divisor used in obtaining the X and Y components of the target's velocity.

VX	X component of the target's velocity.
VY	Y component of the target's velocity.
XC	X coordinate of target's CPA to detecting radar.
XCOF	Product of the jammer and detecting radar coefficients based on the jammer-target-radar geometry.
XJ	X coordinate of the jammer when the target is at its midpoint.
XJJ	X coordinate of the jammer at game time 0.
XJJT	Difference in X coordinates of the jammer's position and the jammer's target position.
XJR	Difference in X coordinates of the detecting radar's position and the jammer's position.
XJT	X coordinate of the jammer's target.
XO	X coordinate of the target's terminal position.
XR	X coordinate of the detecting radar's position.
XRT	Difference in Y coordinates of the detecting radar's position and the target's midpoint position.
X1	X coordinate of the target's initial position.
YC	Y coordinate of target's CPA to detecting radar.
YJ	Y coordinate of the jammer when the target is at its midpoint.
YJJ	Y coordinate of the jammer at game time 0.
YJJT	Difference in Y coordinates of the jammer's position and the jammer's target position.
YJR	Difference in Y coordinates of the detecting radar's position and the jammer's position.
YJT	Y coordinate of the jammer's target.
YO	Y coordinate of the target's terminal position.
YR	Y coordinate of the detecting radar's position.
YRT	Difference in Y coordinates of the detecting radar's position and the target's midpoint position.

Y1	Y coordinate of the target's initial position.
Z1	Target altitude in nautical miles.

15. SUBROUTINE BIDET

A	Coefficient used in solution of bistatic detection and radar horizon equations. See Appendix A for bistatic equation.
A1	2A.
A2	A squared.
B	Similar to A. See Appendix A.
C	Similar to A. See Appendix A.
CC	Constant used in solution of receiver and transmitter radar horizons equations.
CHAR	Constant of bistatic detection equation. See Appendix A.
CHAS	Bistatic radar detection range in clear environment against one square meter target.
COF	Array used only in calling subroutine DTIMD.
COFF	See definition in subroutine JAMM portion of this glossary.
CPRS	Range squared from track CPA to bistatic receiver position.
CPXS	Range squared from track CPA to bistatic transmitter position.
D	Similar to A. See Appendix A.
DELX	Same definition as in subroutine CPA.
DELY	Same definition as in subroutine CPA.
E	Similar to A. See Appendix A.
EE	Constant used in the solution of bistatic receiver and transmitter radar horizon equations.
HJBW	Defined in subroutine JAMM.
HORRS	Receiver's radar horizon range squared.

HORXS	Transmitter's radar horizon range squared.
HRBW	Defined in subroutine JAMM.
IFLAG	Flag set to 1 for stationary targets.
IT	Ship number of bistatic transmitter.
JAM	Array indicating the number of active jammers on each radar frequency band.
JFLAG	Flag set to 1 when the algorithm has completed the jamming section of the detection phase.
JJTBR	Defined in subroutine JAMM.
JRBRG	Defined in subroutine JAMM.
LJBW	Defined in subroutine JAMM.
LTBRG	Defined in subroutine JAMM.
NASM	ASM number.
PJ	Defined in subroutine JAMM.
Q	Track change in Y direction divided by track change in X direction.
RCOF	Defined in subroutine JAMM.
RCOFF	Defined in subroutine JAMM.
RD2	Square of the range from the bistatic receiver to stationary target's position.
RJBRG	Defined in subroutine JAMM.
RJBW	Defined in subroutine JAMM.
RJHS	Defined in subroutine JAMM.
RRAD	Radical part of solution to quadratic equation for time above bistatic receiver's radar horizon.
RRH	Range to receiver's radar horizon.
RRJS	Defined in subroutine JAMM.
RTBRG	Defined in subroutine JAMM.
SUMJP	Defined in subroutine JAMM.

T	An array containing the bistatic detection times.
TBRG	Defined in subroutine JAMM.
TIMC	Time constant based on target's launch time of missile. Otherwise start of game time.
TIME	Array containing the real parts to the solution of the bistatic equation.
TIMEI	Array containing the complex parts to the solution of the bistatic equation.
TIMI	Defined in subroutine JAMM.
TR1	Time target enters receiver's radar horizon range.
TR2	Time target departs receiver's radar horizon range.
TX1	Time target enters transmitter's radar horizon range.
TX2	Time target departs transmitter's radar horizon range.
T1	Time target enters bistatic radar detection envelope.
T1O	Time target is first above both transmitter and receiver's radar horizon.
T2	Time target departs bistatic radar detection envelope.
T2O	Time target is no longer above both the transmitter and receiver's radar horizon.
V	Target's velocity in nautical miles per minute.
VD	Defined in subroutine JAMM.
VX	X component of target velocity.
VY	Y component of target velocity.
XCOF	Defined in subroutine JAMM.
XCOFF	Defined in subroutine JAMM.
XD2	Square of the range from the bistatic transmitter to the stationary target's position.
XJ	Defined in subroutine JAMM.
XJJ	Defined in subroutine JAMM.

XJJT	Defined in subroutine JAMM.
XJR	Defined in subroutine JAMM.
XO	X coordinate of target's terminal position.
XR	X coordinate of bistatic radar receiver position.
XRAD	Similar to RRAD above.
XRC	X coordinate of target track CPA to bistatic receiver.
XRT	Defined in subroutine JAMM.
XX	X coordinate of the bistatic transmitter.
XXC	X coordinate of target track CPA to bistatic transmitter.
X1	X coordinate of target's initial position.
YJ	Defined in subroutine JAMM.
YJJ	Defined in subroutine JAMM.
YJJT	Defined in subroutine JAMM.
YJR	Defined in subroutine JAMM.
YJT	Defined in subroutine JAMM.
YO	Y coordinate of target's terminal position.
YR	Y coordinate of bistatic receiver's position.
YRC	Y coordinate of target track CPA to bistatic receiver.
YRT	Defined in subroutine JAMM.
YX	Y coordinate of the bistatic transmitter position.
YXC	Y coordinate of target track CPA to bistatic transmitter.
Y1	Y coordinate of target's initial position.
ZR	Bistatic receiver antenna height in feet.
ZRN	Bistatic receiver antenna height in nautical miles.
ZX	Bistatic transmitter antenna height in feet.

ZXN	Bistatic transmitter antenna height in nautical miles.
Z1	Target altitude in nautical miles.
Z12	Target altitude in nautical miles squared.

16. SUBROUTINE CPA

DELX	First used as a test variable to determine if track passes through reference position. Second usage is to indicate track change in X direction.
DELY	First used as a test variable to determine if track passes through reference position. Second usage is to indicate track change in Y direction.
Q	Track change in Y direction divided by track change in X direction.
XC	X coordinate of CPA position.
XI	X coordinate of initial track position.
XO	X coordinate of terminal track position.
XP	X coordinate of reference position.
YC	Y coordinate of CPA position.
YI	Y coordinate of initial track position.
YO	Y coordinate of terminal track position.
YP	Y coordinate of reference position.

17. SUBROUTINE RCHECK

DELX	The distance along the X axis from the raider position to the potential target position.
DELY	The distance along the Y axis from the raider position to the potential target position.
DIS	The square of the distance from the raider to the potential target.
HT	The height of the highest radar on the potential target ship.
HTR	The radar horizon for HT.

ID	The class number of the potential target ship.
IR	The raider number.
IT	The potential target ship number.
K	Flag for go/nogo situation.
RADAR	The combined radar horizons of the raider and the potential target.
RADAR2	RADAR squared.
RR	The maximum theoretical range for the raider's radar.
RR2	RR squared.
RTR	Radar horizon for the raider.
SHIP	The table containing the BLUE ship location information.
XS	The raider's present position along the X axis.
XT	The ship's present position along the X axis.
YS	The raider's present position along the Y axis.
YT	The ship's present position along the Y axis.

18. SUBROUTINE TMDASM

A	Coefficient A in the quadratic equation.
B	Coefficient B in the quadratic equation.
B1	B in $Y = mX + b$
C	Coefficient C in the quadratic equation.
DELTAX	The distance in the X direction from present position to the end of game position.
DELTAY	The distance in the Y direction from present position to the end of game position.
DELX	The distance in the X direction from the intercept position to the present position.
DELY	The distance in the Y direction from the intercept position to the present position.

DEX	The distance in the X direction from the firing ship to the target at present time.
DEY	The distance in the Y direction from the firing ship to the target at present time.
DIC	The distance in either the X or Y direction from intercept to end of game.
DIF	The distance in either the X or Y direction from present position to end of game position.
D1	Distance from present position to first intercept point, squared.
D2	Distance from present position to second intercept point, squared.
IFLAG	Flag indicating target is already within the indicated range.
IRAID	Raider number of target or launching raid.
ISAMBT	Battery number.
ITS	Target ship number when target is an ASM/SSM.
KFLAG	Flag indicating target moving in a north or south direction.
M	Raider number.
NFS	Firing ship number.
RAID	The raid array.
RIP	The range to the target or to intercept, whichever is smaller.
ROOT	$B^2 - 4AC$.
SHIP	The ship array.
SLM	m in $Y = mX + b$.
SRG	Range of interest.
TIME	Time target crosses range inbound.
TIML	Time target crosses range outbound.
TML	Present game time.
TOAST	$B^2 - 4AC$.

VEL	Target speed.
XI	Inbound crossing point.
YI	Inbound crossing point.

19. SUBROUTINE TMDBOM

A	A in the quadratic equation.
B	B in the quadratic equation.
BA	b in $Y = mX + b$.
C	C in the quadratic equation.
DELTAX	The distance from present position to the end of game position in the X direction.
DELTAY	The distance from the present position to the end of game position in the Y direction.
DELX	Distance from the intercept point to present position in the X direction.
DELY	Distance in the Y direction from the intercept point to the present position.
DIC	Distance from the intercept point to the end of game position in the X direction.
DIF	Distance from the present position to the end of game position in the X direction.
IR	Raider number.
RAID	Raid array.
RGE	The launch range.
SLM	m in $Y = mX + b$.
T	Time raider will reach the launch range.
VEL	The raider speed.

20. SUBROUTINE LOCTIM

D	The distance between the raider end of game position and the position stored in the RAID table.
DELTAX	The distance along the X axis from the end of game position to the position stored in the RAID table.
DELTAY	Distance along the Y axis.
DL	Distance traveled in the time interval defined as the difference between the time stored in the RAID table and the time for which the raider position is desired.
K	The raider number.
PTIME	The time stored in the RAID table.
RAID	The table that contains the position and weapon information.
T	The time for which the raider position is desired.
VEL	The raider speed.
XP	The X position at time T.
XZ	The X position stored in the RAID table.
YP	The Y position at time T.
YZ	The Y position stored in the RAID table.

21. SUBROUTINE ASMTIM

ASMT	The table containing the data on the RED missile engagement.
D	The distance between the missile launch point and the impact point.
DL	The distance the missile will travel in the time defined as the difference between the launch time and the time for which the missile position is desired.
ID	The RED missile type.
M	The RED missile target number.
MA	The RED missile number for table lookup.

T	The time for which the ASM/SSM position is desired.
VEL	The missile speed.
XP	The X position at the time T.
YP	The Y position at the time T.

```
// EXEC FORTCLGP,REGION.GO=350K
//SYSIN DD *

                                   MAIN

      REAL *8RAT,COSI,SINI,RRK,RRS,BETA,ALFA,GAMA,RRC                   MAIN  10
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMMAIN  20
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEEMAIN  30
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOMAIN  40
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QMAIN  50
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),MAIN  60
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4MAIN  70
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             MAIN  80
      DIMENSION HISO(100)                                               MAIN  90
C                                                                       MAIN 100
C   AMF          A SMALL CONSTANT USE TO CONVERT REAL NUMBERS TO        MAIN 110
C                INTEGERS                                               MAIN 120
C                                                                       MAIN 130
C   ASMT         THE ARRAY WITH THE ASM LAUNCH, TARGET, ALTITUDE ETC., DATAMAIN 140
C                                                                       MAIN 150
C   CHANEL       AN ARRAY USED TO KEEP TRACK OF WHAT AEGIS CHANNELS ARE MAIN 160
C                CURRENTLY ENGAGED IN SAM INTERCEPTS                    MAIN 170
C                                                                       MAIN 180
C   CHECK        THE INTERNAL MEASUREMENT OF THREAT                     MAIN 190
C                                                                       MAIN 200
C   HISA         A VECTOR USED WITH HISTG                               MAIN 210
C                                                                       MAIN 220
C   HISX         VECTOR FOR USE WITH HISTG                              MAIN 230
C                                                                       MAIN 240
C   IBAT         THE ARRAY THAT CONTAINS THE NUMBER OF MISSILES LEFT IN MAIN 250
C                EACH SAM BATTERY                                       MAIN 260
C                                                                       MAIN 270
C   IFAG         KEEPS TRACK OF THE NUMBER OF ASM/SSM ENGAGED           MAIN 280
C                BY THE FLEET                                           MAIN 290
C                                                                       MAIN 300
C   IFBG         SAME AS IFAG, BUT FOR RAIDERS                          MAIN 310
C                                                                       MAIN 320
C   IFIRST       THE POINTING INDICATOR USED IN TARGET                  MAIN 330
C                                                                       MAIN 340
C   IFLASK       THE FLAG INDICATING THE FIRST AIRLAUNCHED RED          MAIN 350
C                MISSILE HAS BEEN FIRED                                 MAIN 360
C                                                                       MAIN 370
C   IGAGE        THE ARRAY THAT KEEPS TRACK OF WHICH TARGETS            MAIN 380
C                HAVE BEEN ENGAGED                                      MAIN 390
C                                                                       MAIN 400
C   IHIT         KEEPS TRACK OF THE HITS ON INDIVIDUAL SHIPS            MAIN 410
```

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C                                                                       MAIN 420
C    ISAG      VECTOR TO KEEP TRACK OF HOW MANY ASM/SSMS A SHIP         MAIN 430
C              FIRST ENGAGED                                            MAIN 440
C                                                                       MAIN 450
C    ISBG      SAME AS ISAG, BUT FOR RAIDERS                            MAIN 460
C                                                                       MAIN 470
C    ISEED     THE INPUT FOR THE CALL RANDOM RANDOM NUMBER GENERATOR    MAIN 480
C                                                                       MAIN 490
C    ITEMS     THE NUMBER OF EVENTS THAT HAVE BEEN RETRIEVED FROM THE   MAIN 500
C              EVENTS LIST                                              MAIN 510
C                                                                       MAIN 520
C    IVENTS    THE EVENTS LIST                                          MAIN 530
C                                                                       MAIN 540
C    JACK      USED TO KEEP STATISTICS OF ENGAGEMENT AND DETECTION      MAIN 550
C                                                                       MAIN 560
C    JAM       A VECTOR TO KEEP TRACK OF THE PRESENCE OF JAMMING ON     MAIN 570
C              EACH OF THE FOUR SIMULATED RADAR FREQUENCY BANDS         MAIN 580
C                                                                       MAIN 590
C    KMART     AN ARRAY USED WITH ZLNKA TO DETERMINE THE REORDERING     MAIN 600
C              OF THE INPUT VECTOR                                      MAIN 610
C                                                                       MAIN 620
C    KOUNT     THE ITERATION IN PROGRESS                                MAIN 630
C                                                                       MAIN 640
C    LOVER     THE NUMBER OF EVENTS CURRENTLY IN THE EVENTS LIST        MAIN 650
C                                                                       MAIN 660
C    MAMBAT    THE NUMBER OF AVAILABLE SAM BATTERIES                    MAIN 670
C                                                                       MAIN 680
C    MARY      THE VECTOR THAT KEEPS THE TOATAL HITS STATISTIC          MAIN 690
C                                                                       MAIN 700
C    MISLFT    AN ARRAY TO KEEP TRACK OF ASMS LEFT ON BOARD EACH RAIDER MAIN 710
C                                                                       MAIN 720
C    NADAR     THE ARRAY CONTAINING SEARCH RADAR, FC RADAR, AND LAUNCHERMAIN 730
C              UP/DOWN STATUS                                           MAIN 740
C                                                                       MAIN 750
C    NASM      THE NUMBER OF ASMS LAUNCHED                              MAIN 760
C                                                                       MAIN 770
C    NONO      THE ARRAY THAT GIVES THE SHIP VS. ASM/RAIDER  AN OK OR   MAIN 780
C              THE REASON FOR NON ENGAGEMENT                            MAIN 790
C                                                                       MAIN 800
C    NPGS      A FLAG USED IN PRIOR                                     MAIN 810
C                                                                       MAIN 820
C    NR        THE NUMBER OF RED RAIDERS                                MAIN 830
C                                                                       MAIN 840
C    NRTGT     A VECTOR LISTING THE TARGET LIST ASSIGNED TO EACH RAIDER MAIN 850
C                                                                       MAIN 860
C    NS        THE NUMBER OF SHIPS IN THE BLUE FLEET                    MAIN 870
C                                                                       MAIN 880
C    NSAM      NUMBER OF SALVOS FIRED                                   MAIN 890
```

```
C
C     PLIST       THE ARRAY CONTAINING THE TARGETING PROBABILITIES
C
C     QRT         A DUMMY ARRAY USED FOR STORING RANDOM NUMBERS
C
C     RAID        THE ARRAY WITH THE RED RAIDER DATA
C
C     REASON      A FAILURE TO SHOOT A SAM CODE
C
C     RELOAD      THE ARRAY THAT TELLS WHETHER A LAUNCHER IS THROUGH
C                 WITH ITS RELOAD CYCLE
C
C     RXATA       A DUMMY ARRAY USED TO LOAD INPUT
C
C     SAMASM      THE ARRAY WITH THE PARTICULAR SAM AND ASM ENGAGEMENT DATA
C
C     SMAT        THE ARRAY WITH THE SAM FIRING RESULT
C
C
C     SHIP        THE ARRAY WITH BLUE FORCE INFO
C
C     STATS       THE ARRAY FOR COMPILING SHIP DETECTION AND ENGAGEMENT
C                 STATISTICS
C
C     TCF         USED TO REORDER THE CHANNEL AVAILABULITY TIMES
C
C     TGTAV       THE COORDINATION OF FIRE ARRAY
C
C     TMAX        THE TIME BY WHICH ALL AIR ASM LAUNCHES MUST BE COMPLETED
C
C     X           THE INPUT ARRAY HOLDING SCENARIO DATA, BLUE SHIP(AC)
C                 DATA AND THE RED RAIDER DATA
C
C
      CALL OVFLOW
C
      AMF = 5.0E-3
C
C
C
      DO 30 I=1,40
C
C
C
      DO 20 J=1,6
      PLIST(I,J) = 0.
   20 CONTINUE
C
```

```
C                                                                       MAIN1380
C                                                                       MAIN1390
   30 CONTINUE                                                          MAIN1400
C                                                                       MAIN1410
C          SET ALL  X  ARRAY TO ZERO                                    MAIN1420
C                                                                       MAIN1430
      DO 40 I=1,2744                                                    MAIN1440
      X(I) = 0.                                                         MAIN1450
   40 CONTINUE                                                          MAIN1460
C                                                                       MAIN1470
C                                                                       MAIN1480
      DO 50 I=1,100                                                     MAIN1490
      MARY(I) = 0                                                       MAIN1500
   50 CONTINUE                                                          MAIN1510
C                                                                       MAIN1520
C          READ IN THE DATA                                             MAIN1530
C                                                                       MAIN1540
      DO 70 IJ=1,548                                                    MAIN1550
      READ (5,1170) IRT,RXATA                                           MAIN1560
      IF (IRT.EQ.0) GO TO 80                                            MAIN1570
      JRT = IRT+4                                                       MAIN1580
C                                                                       MAIN1590
      DO 60 J=IRT,JRT                                                   MAIN1600
      X(J) = RXATA(J-IRT+1)                                             MAIN1610
   60 CONTINUE                                                          MAIN1620
C                                                                       MAIN1630
   70 CONTINUE                                                          MAIN1640
C                                                                       MAIN1650
   80 ISEED = IFIX(X(11)+AMF)                                           MAIN1660
      NI = IFIX(X(6)+AMF)                                               MAIN1670
      IF (X(82).EQ.0.) X(82)=120.                                       MAIN1680
      INSECT = ISEED                                                    MAIN1690
C                                                                       MAIN1700
C          PRINT OUT THE X ARRAY AS READ INTO THE COMPUTER              MAIN1710
C                                                                       MAIN1720
      IF (X(12).EQ.0.) GO TO 100                                        MAIN1730
      WRITE (6,1190)                                                    MAIN1740
C                                                                       MAIN1750
      DO 90 I=1,343                                                     MAIN1760
      IJ = I+343                                                        MAIN1770
      IK = IJ+343                                                       MAIN1780
      IL = IK+343                                                       MAIN1790
      IM = IL+343                                                       MAIN1800
      IN = IM+343                                                       MAIN1810
      IO = IN+343                                                       MAIN1820
      IP = IO+343                                                       MAIN1830
      WRITE (6,1200) I,X(I),IJ,X(IJ),IK,X(IK),IL,X(IL),IM,X(IM),IN,X(IN)MAIN1840
     1,IO,X(IO),IP,X(IP)                                                MAIN1850
```

```
   90 CONTINUE                                                           MAIN1860
C                                                                        MAIN1870
C       COMPUTE WEAPON HORIZON                                           MAIN1880
C                                                                        MAIN1890
  100 IF (X(81).GT.0.) GO TO 110                                         MAIN1900
      X(81) = 1.23                                                       MAIN1910
C                                                                        MAIN1920
  110 DO 120 I=2002,2192,10                                              MAIN1930
      IF (X(I-1).EQ.0.) GO TO 130                                        MAIN1940
      IK = I+7                                                           MAIN1950
      X(IK) = X(81)*SQRT(X(I))                                           MAIN1960
  120 CONTINUE                                                           MAIN1970
C                                                                        MAIN1980
C         CHANGE TRUE ANGLES TO CARTESIAN FOR SHIPS                      MAIN1990
C         SET SAM VELOCITY TO NM/MIN                                     MAIN2000
C                                                                        MAIN2010
  130 IN = IFIX(X(78)+AMF)                                               MAIN2020
C                                                                        MAIN2030
      DO 140 I=1,10                                                      MAIN2040
      ID = 502+(I-1)*40                                                  MAIN2050
      IK = ID+7                                                          MAIN2060
      IF (X(ID-1).EQ.0.) GO TO 150                                       MAIN2070
      X(ID) = X(ID)/60.                                                  MAIN2080
      X(IK) = X(IK)/60.                                                  MAIN2090
  140 CONTINUE                                                           MAIN2100
C                                                                        MAIN2110
C          CONVERT RADAR BEAM WIDTH TO 1/2 BEAM WIDTH IN RADIANS         MAIN2120
C          AND REPLACE SIDELOBE COEFFICIENT IN -DB WITH DIRECTIVE LOSSES MAIN2130
C                                                                        MAIN2140
  150 RAT = .8726646D-2                                                  MAIN2150
C                                                                        MAIN2160
      DO 160 NN=1,15                                                     MAIN2170
      NX = 20*(NN-1)                                                     MAIN2180
      IF (X(903+NX).EQ.0.) GO TO 170                                     MAIN2190
      BWR = DBLE(X(911+NX))*RAT                                          MAIN2200
      X(911+NX) = BWR                                                    MAIN2210
      BWR = X(904+NX)                                                    MAIN2220
      X(904+NX) = 10.**(BWR/10.)                                         MAIN2230
  160 CONTINUE                                                           MAIN2240
C                                                                        MAIN2250
  170 NS = IFIX(X(88)+AMF)                                               MAIN2260
      IF (IN.EQ.1) GO TO 190                                             MAIN2270
C                                                                        MAIN2280
      DO 180 I=1,NS                                                      MAIN2290
      IX = 5*(I-1)+1203                                                  MAIN2300
      X(IX) = 450.-X(IX)                                                 MAIN2310
      IF (X(IX).GE.360.) X(IX)=X(IX)-360.                                MAIN2320
  180 CONTINUE                                                           MAIN2330
```

```
C                                                                       MAIN2340
C        CHANGE RAIDER BEARINGS AND COURSES TO CARTESIAN                MAIN2350
C        FIGURE FOURTH ROOT OF RAIDER AND WEAPON CROSS SECTION          MAIN2360
C        CHANGE KNOTS TO NM/MIN                                         MAIN2370
C         COMPUTE 1/2 JAMMER BEAM WIDTH IN RADIANS                      MAIN2380
C         REPLACE SIDELOBE COEFFICIENT IN -DB WITH DIRECTIVE LOSSES     MAIN2390
C                                                                       MAIN2400
 190  DO 200 I=1,10                                                     MAIN2410
      IX = 20*(I-1)                                                     MAIN2420
      IF (X(IX+1815).EQ.0.) GO TO 210                                   MAIN2430
      X(IX+1814) = X(1814+IX)/60.                                       MAIN2440
      RRC = DBLE(X(IX+1815))                                            MAIN2450
      RRS = DSQRT(RRC)                                                  MAIN2460
      X(IX+1816) = DSQRT(RRS)                                           MAIN2470
      IF (X(IX+1817).EQ.0.) GO TO 200                                   MAIN2480
      BWJ = DBLE(X(IX+1817))*RAT                                        MAIN2490
      X(IX+1817) = BWJ                                                  MAIN2500
      BWJ = X(IX+1818)                                                  MAIN2510
      X(IX+1818) = 10.**(BWJ/10.)                                       MAIN2520
 200  CONTINUE                                                          MAIN2530
C                                                                       MAIN2540
C                                                                       MAIN2550
 210  DO 220 I=1,20                                                     MAIN2560
      IX = (I-1)*10                                                     MAIN2570
      IT = IX+2001                                                      MAIN2580
      IF (X(IT+5).EQ.0.) GO TO 230                                      MAIN2590
      X(IT) = X(IT)/60.                                                 MAIN2600
      RRC = DBLE(X(IX+2006))                                            MAIN2610
      RRS = DSQRT(RRC)                                                  MAIN2620
      X(IX+2010) = DSQRT(RRS)                                           MAIN2630
 220  CONTINUE                                                          MAIN2640
C                                                                       MAIN2650
 230  NR = IFIX(X(89)+AMF)                                              MAIN2660
C                                                                       MAIN2670
      DO 240 I=1,NR                                                     MAIN2680
      IX = (I-1)*6                                                      MAIN2690
      X(IX+2205) = 450.-X(IX+2205)                                      MAIN2700
      IF (X(IX+2205).GE.360.) X(IX+2205)=X(IX+2205)-360.                MAIN2710
      X(IX+2203) = 450.-X(IX+2203)                                      MAIN2720
      IF (X(IX+2203).GE.360.) X(IX+2203)=X(IX+2203)-360.                MAIN2730
 240  CONTINUE                                                          MAIN2740
C                                                                       MAIN2750
      READ (5,1210) NRTGT                                               MAIN2760
      IF (X(12).EQ.0.) GO TO 260                                        MAIN2770
C                                                                       MAIN2780
      DO 250 I=1,10                                                     MAIN2790
      IA = I+10                                                         MAIN2800
      IB = I+20                                                         MAIN2810
```

```
      IC = I+30                                                         MAIN2820
      ID = I+40                                                         MAIN2830
      IE = I+50                                                         MAIN2840
      IF = I+60                                                         MAIN2850
      IG = I+70                                                         MAIN2860
      IH = I+80                                                         MAIN2870
      WRITE (6,1220) I,NRTGT(I),IA,NRTGT(IA),IB,NRTGT(IB),IC,NRTGT(IC),IMAIN2880
     1D,NRTGT(ID),IE,NRTGT(IE),IF,NRTGT(IF),IG,NRTGT(IG),IH,NRTGT(IH)   MAIN2890
  250 CONTINUE                                                          MAIN2900
C                                                                       MAIN2910
      WRITE (6,1240)                                                    MAIN2920
  260 READ (5,1230) PLIST                                               MAIN2930
      IF (X(12).EQ.0.) GO TO 280                                        MAIN2940
C                                                                       MAIN2950
      DO 270 I=1,40                                                     MAIN2960
      WRITE (6,1250) I,PLIST(I,1),I,PLIST(I,2),I,PLIST(I,3),I,PLIST(I,4)MAIN2970
     1,I,PLIST(I,5),I,PLIST(I,6)                                        MAIN2980
  270 CONTINUE                                                          MAIN2990
C                                                                       MAIN3000
C                                                                       MAIN3010
  280 DO 340 I=1,NS                                                     MAIN3020
      IX = 5*(I-1)+1204                                                 MAIN3030
      X(IX) = 450.-X(IX)                                                MAIN3040
      IF (X(IX).GE.360.) X(IX)=X(IX)-360.                               MAIN3050
      X(IX+1) = 450.-X(IX+1)                                            MAIN3060
      IF (X(IX+1).GE.360.) X(IX+1)=X(IX+1)-360.                         MAIN3070
C                                                                       MAIN3080
      DO 290 K=1,19                                                     MAIN3090
      NADAR(I,K) = 0                                                    MAIN3100
  290 CONTINUE                                                          MAIN3110
C                                                                       MAIN3120
C         SET THE SHIP TABLE                                            MAIN3130
C                                                                       MAIN3140
      IJ = 1201+(I-1)*5                                                 MAIN3150
      IK = IJ+1                                                         MAIN3160
      IL = IK+1                                                         MAIN3170
      IM = 101+(X(IJ)-1)*40                                             MAIN3180
      SHIP(I,1) = X(IJ)                                                 MAIN3190
      IF (IN.EQ.0) GO TO 300                                            MAIN3200
      SHIP(I,2) = X(IK)                                                 MAIN3210
      SHIP(I,3) = X(IL)                                                 MAIN3220
      GO TO 310                                                         MAIN3230
  300 RAT = DBLE(X(IL))                                                 MAIN3240
      RD = RADIAN(RAT)                                                  MAIN3250
      SHIP(I,2) = X(IK)*COS(RD)                                         MAIN3260
      SHIP(I,3) = X(IK)*SIN(RD)                                         MAIN3270
  310 IS = IM+20                                                        MAIN3280
      SHIP(I,4) = X(IS)                                                 MAIN3290
```

```
      SHIP(I,5) = FLOAT(IM)                                             MAIN3300
      IT = X(IM)                                                        MAIN3310
C                                                                       MAIN3320
      DO 320 K=1,4                                                      MAIN3330
      IBAT(I,K) = 0                                                     MAIN3340
  320 CONTINUE                                                          MAIN3350
C                                                                       MAIN3360
      IF (IT.GT.0) GO TO 330                                            MAIN3370
      SHIP(I,6) = 0.                                                    MAIN3380
      GO TO 340                                                         MAIN3390
  330 SHIP(I,6) = 1.                                                    MAIN3400
  340 CONTINUE                                                          MAIN3410
C                                                                       MAIN3420
C                                                                       MAIN3430
      DO 360 I=1,10                                                     MAIN3440
C                                                                       MAIN3450
      DO 350 J=1,3                                                      MAIN3460
      ND = 120+(I-1)*40+J*2                                             MAIN3470
      X(ND) = 450.-X(ND)                                                MAIN3480
      IF (X(ND).GE.360.) X(ND)=X(ND)-360.                               MAIN3490
      X(ND+1) = 450.-X(ND+1)                                            MAIN3500
      IF (X(ND+1).GE.360.) X(ND+1)=X(ND+1)-360.                         MAIN3510
  350 CONTINUE                                                          MAIN3520
C                                                                       MAIN3530
  360 CONTINUE                                                          MAIN3540
C                                                                       MAIN3550
C         THE INITIAL RAID TABLE                                        MAIN3560
C                                                                       MAIN3570
      IF (X(55).EQ.0.) GO TO 370                                        MAIN3580
      CALL SETIMX                                                       MAIN3590
C                                                                       MAIN3600
  370 DO 490 I=1,NR                                                     MAIN3610
      IJ = 2201+(I-1)*6                                                 MAIN3620
      IK = IJ+1                                                         MAIN3630
      IL = IJ+2                                                         MAIN3640
      IM = IJ+3                                                         MAIN3650
      IN = IJ+4                                                         MAIN3660
      IT = IFIX(X(IJ)+AMF)                                              MAIN3670
      JC = 1801+(IT-1)*20                                               MAIN3680
      VELR = X(JC+13)                                                   MAIN3690
      RAID(I,1) = FLOAT(JC)                                             MAIN3700
      ALFA = DBLE(X(IL))                                                MAIN3710
      RAT = RADIAN(ALFA)                                                MAIN3720
      COSI = DCOS(RAT)                                                  MAIN3730
      SINI = DSIN(RAT)                                                  MAIN3740
      RAID(I,2) = 0.                                                    MAIN3750
      RAID(I,3) = DBLE(X(IK))*COSI                                      MAIN3760
      RAID(I,4) = DBLE(X(IK))*SINI                                      MAIN3770
```

```
      IU = IFIX(X(JC+3)+AMF)                                            MAIN3780
      RRK = DBLE(X(82)*VELR)                                            MAIN3790
      RRS = DBLE(X(IN))                                                 MAIN3800
      RAT = RADIAN(RRS)                                                 MAIN3810
      RAID(I,5) = RRK*DCOS(RAT)+RAID(I,3)                               MAIN3820
      RAID(I,6) =  RRK*DSIN(RAT)+RAID(I,4)                              MAIN3830
      IF (IU.GT.0) GO TO 390                                            MAIN3840
  380 RAID(I,7) = RAID(I,5)                                             MAIN3850
      RAID(I,8) = RAID(I,6)                                             MAIN3860
      GO TO 450                                                         MAIN3870
  390 IW = IFIX(X(JC+5)+AMF)                                            MAIN3880
      IX = 2003+(IU-1)*10                                               MAIN3890
      IF (IW.EQ.0) GO TO 400                                            MAIN3900
      IY = 2003+(IW-1)*10                                               MAIN3910
      IF ((X(IX)-X(IY)).LT.0.) GO TO 410                                MAIN3920
      RK = X(IX)                                                        MAIN3930
      RB = X(IY)                                                        MAIN3940
      GO TO 420                                                         MAIN3950
  400 RK = X(IX)                                                        MAIN3960
      GO TO 430                                                         MAIN3970
  410 RK = X(IY)                                                        MAIN3980
      RB = X(IX)                                                        MAIN3990
  420 CALL TMDBOM (I,RB,T)                                              MAIN4000
      RAID(I,16) = T                                                    MAIN4010
  430 CALL TMDBOM (I,RK,T)                                              MAIN4020
      IF (T.GT.X(82)) GO TO 380                                         MAIN4030
      IF (T.EQ.0.) GO TO 440                                            MAIN4040
      CALL LOCTIM (I,T,3,XX,YY)                                         MAIN4050
      RAID(I,7) = XX                                                    MAIN4060
      RAID(I,8) = YY                                                    MAIN4070
      GO TO 450                                                         MAIN4080
  440 RAID(I,7) = RAID(I,3)                                             MAIN4090
      RAID(I,8) = RAID(I,4)                                             MAIN4100
      GO TO 450                                                         MAIN4110
  450 RAID(I,9) = X(IM)                                                 MAIN4120
      RAID(I,10) = X(81)*SQRT(X(IM))                                    MAIN4130
      IF (IU.EQ.0) GO TO 470                                            MAIN4140
      IF (IW.EQ.0) GO TO 460                                            MAIN4150
      IF (X(IX).GT.X(IY)) GO TO 460                                     MAIN4160
      RAID(I,11) = X(JC+5)                                              MAIN4170
      GO TO 480                                                         MAIN4180
  460 RAID(I,11) = X(JC+3)                                              MAIN4190
      GO TO 480                                                         MAIN4200
  470 RAID(I,11) = 0.                                                   MAIN4210
  480 RAID(I,12) = X(JC+2)+X(JC+4)                                      MAIN4220
  490 CONTINUE                                                          MAIN4230
C                                                                       MAIN4240
      IF (X(24).EQ.2..OR.X(24).EQ.3.) CALL DISPL                        MAIN4250
```

```
      IF (X(24).EQ.1..OR.X(24).EQ.3.) CALL RAIDIS                       MAIN4260
C                                                                       MAIN4270
C      GET THE NUMBER OF SAM IN THE FLEET                               MAIN4280
C                                                                       MAIN4290
      NMIF = 0                                                          MAIN4300
C                                                                       MAIN4310
      DO 510 L=1,NS                                                     MAIN4320
      IF (SHIP(L,6).EQ.0.) GO TO 510                                    MAIN4330
      IT = IFIX(SHIP(L,5)+AMF)                                          MAIN4340
C                                                                       MAIN4350
      DO 500 K=1,4                                                      MAIN4360
      IF (X(IT-1+K).EQ.0.) GO TO 510                                    MAIN4370
      MT = IFIX(X(IT-1+K)+AMF)                                          MAIN4380
      NT = 527+(MT-1)*40                                                MAIN4390
      NMIF = NMIF+IFIX(X(NT)+AMF)                                       MAIN4400
  500 CONTINUE                                                          MAIN4410
C                                                                       MAIN4420
  510 CONTINUE                                                          MAIN4430
C                                                                       MAIN4440
      X(75) = FLOAT(NMIF)                                               MAIN4450
      WRITE (6,1260) NMIF                                               MAIN4460
      IF (X(2).EQ.1.) GO TO 610                                         MAIN4470
C                                                                       MAIN4480
      DO 600 I=1,NS                                                     MAIN4490
      IS = IFIX(SHIP(I,5)+AMF)                                          MAIN4500
C                                                                       MAIN4510
      DO 520 J=4,6                                                      MAIN4520
      K = J-3                                                           MAIN4530
      IF (X(IS+J).EQ.0.) GO TO 530                                      MAIN4540
      NADAR(I,K) = 1                                                    MAIN4550
  520 CONTINUE                                                          MAIN4560
C                                                                       MAIN4570
C                                                                       MAIN4580
  530 DO 590 J=1,4                                                      MAIN4590
      IP = IFIX(X(IS+J-1)+AMF)                                          MAIN4600
      IF (IP.EQ.0) GO TO 600                                            MAIN4610
C                                                                       MAIN4620
      DO 570 L=1,3                                                      MAIN4630
      IA = IFIX(X(516+(IP-1)*40+2*L)+AMF)                               MAIN4640
      IF (IA.GT.0) GO TO 560                                            MAIN4650
      GO TO (540,580,580), L                                            MAIN4660
C                                                                       MAIN4670
  540 DO 550 LK=1,3                                                     MAIN4680
      NADAR(I,(3+(J-1)*3+LK))=2                                         MAIN4690
  550 CONTINUE                                                          MAIN4700
C                                                                       MAIN4710
      GO TO 580                                                         MAIN4720
  560 NADAR(I,(3+(J-1)*3+L))=1                                          MAIN4730
```

```
  570 CONTINUE                                                                  MAIN4740
C                                                                               MAIN4750
  580 NADAR(I,(15+J)) = 1                                                       MAIN4760
  590 CONTINUE                                                                  MAIN4770
C                                                                               MAIN4780
  600 CONTINUE                                                                  MAIN4790
C                                                                               MAIN4800
  610 IF (X(15).EQ.0.0) GO TO 630                                               MAIN4810
      WRITE (6,1180)                                                            MAIN4820
C                                                                               MAIN4830
      DO 620 I=1,343                                                            MAIN4840
      IJ = I+343                                                                MAIN4850
      IK = IJ+343                                                               MAIN4860
      IL = IK+343                                                               MAIN4870
      IM = IL+343                                                               MAIN4880
      IN = IM+343                                                               MAIN4890
      IO = IN+343                                                               MAIN4900
      IP = IO+343                                                               MAIN4910
      WRITE (6,1200) I,X(I),IJ,X(IJ),IK,X(IK),IL,X(IL),IM,X(IM),IN,X(IN)MAIN4920
     1,IO,X(IO),IP,X(IP)                                                        MAIN4930
  620 CONTINUE                                                                  MAIN4940
C                                                                               MAIN4950
C          START THE GAME                                                       MAIN4960
C                                                                               MAIN4970
  630 DO 990 I=1,NI                                                             MAIN4980
      KOUNT = I                                                                 MAIN4990
      CALL EFFECT                                                               MAIN5000
      IJ = IFIX(X(75)+AMF)                                                      MAIN5010
      WRITE (6,1270) KOUNT,IJ                                                   MAIN5020
      WRITE (6,1280) KOUNT                                                      MAIN5030
C                                                                               MAIN5040
C                 PRINT THE ASM TABLE                                           MAIN5050
C                                                                               MAIN5060
      WRITE (6,1290)                                                            MAIN5070
C                                                                               MAIN5080
      DO 640 L=1,NASM                                                           MAIN5090
      LA = L+90                                                                 MAIN5100
      WRITE (6,1300) LA,(ASMT(L,J),J=1,8)                                       MAIN5110
  640 CONTINUE                                                                  MAIN5120
C                                                                               MAIN5130
      IM = 0                                                                    MAIN5140
C                                                                               MAIN5150
      DO 650 L=1,NR                                                             MAIN5160
      IF (RAID(L,13).GT.0.) IM=IM+1                                             MAIN5170
  650 CONTINUE                                                                  MAIN5180
C                                                                               MAIN5190
      WRITE (6,1310) NR,IM                                                      MAIN5200
      WRITE (6,1320)                                                            MAIN5210
```

```
      WRITE (6,1330) ((SAMASM(L,J),J=1,6),L=1,NSAM)                     MAIN5220
C                                                                       MAIN5230
C          FORMULATE THE STATISTICS FOR EACH ITERATION                  MAIN5240
C                                                                       MAIN5250
      ILF = 0                                                           MAIN5260
      ILS = 0                                                           MAIN5270
      IKS = 0                                                           MAIN5280
      IIF = 0                                                           MAIN5290
      ITS = 0                                                           MAIN5300
      IMF = 0                                                           MAIN5310
C                                                                       MAIN5320
      DO 720 L=1,NASM                                                   MAIN5330
      IL = IFIX(ASMT(L,1)+AMF)                                          MAIN5340
      IL = IL+1                                                         MAIN5350
      GO TO (660,670,680,690,700,710), IL                               MAIN5360
  660 ILF = ILF+1                                                       MAIN5370
      GO TO 720                                                         MAIN5380
  670 ILS = ILS+1                                                       MAIN5390
      GO TO 720                                                         MAIN5400
  680 IKS = IKS+1                                                       MAIN5410
      GO TO 720                                                         MAIN5420
  690 IIF = IIF+1                                                       MAIN5430
      GO TO 720                                                         MAIN5440
  700 ITS = ITS+1                                                       MAIN5450
      GO TO 720                                                         MAIN5460
  710 IMF = IMF+1                                                       MAIN5470
  720 CONTINUE                                                          MAIN5480
C                                                                       MAIN5490
      X(61) = X(61)+FLOAT(NASM)                                         MAIN5500
      X(62) = X(62)+FLOAT(ILF)                                          MAIN5510
      X(63) = X(63)+FLOAT(IKS)                                          MAIN5520
      X(64) = X(64)+FLOAT(IIF)                                          MAIN5530
      X(65) = X(65)+FLOAT(IMF)                                          MAIN5540
      X(69) = X(69)+FLOAT(ILS)                                          MAIN5550
      X(70) = X(70)+FLOAT(ITS)                                          MAIN5560
      WRITE (6,1340) KOUNT,ITS                                          MAIN5570
      IM = NASM-IMF                                                     MAIN5580
      IF (IM.NE.0) GO TO 730                                            MAIN5590
      P1 = 0.                                                           MAIN5600
      PC2 = 0.                                                          MAIN5610
      PC3 = 0.                                                          MAIN5620
      GO TO 740                                                         MAIN5630
  730 PC1 = FLOAT(IM)                                                   MAIN5640
      P1 = (FLOAT(ILF)/PC1)*100.                                        MAIN5650
      P2 = FLOAT(IM)-FLOAT(ILF)                                         MAIN5660
      PC2 = (FLOAT(IKS)/P2)*100.                                        MAIN5670
      PC3 = (FLOAT(IIF)/P2)*100.                                        MAIN5680
  740 PC4 = FLOAT(NASM)                                                 MAIN5690
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```
      PC5 = (FLOAT(IMF)/PC4)*100.                                       MAIN5700
      WRITE (6,1350) IM,ILF,P1,IKS,PC2,IIF,PC3                          MAIN5710
      WRITE (6,1360) IMF,PC5                                            MAIN5720
      JL = 0                                                            MAIN5730
      IL = 0                                                            MAIN5740
      IK = NMIF-IFIX(X(75)+AMF)                                         MAIN5750
      IF (NSAM.EQ.0) GO TO 770                                          MAIN5760
C                                                                       MAIN5770
      DO 760 L=1,NSAM                                                   MAIN5780
      IN = IFIX(SAMASM(L,5))                                            MAIN5790
      IF (IN.NE.-1) GO TO 750                                           MAIN5800
      IL = IL+IFIX(SMAT(L,10)+AMF)                                      MAIN5810
      GO TO 760                                                         MAIN5820
  750 IF (IN.NE.0) GO TO 760                                            MAIN5830
      JL = JL+IFIX(SMAT(L,10)+AMF)                                      MAIN5840
  760 CONTINUE                                                          MAIN5850
C                                                                       MAIN5860
      X(66) = X(66)+FLOAT(IK)                                           MAIN5870
      X(67) = X(67)+FLOAT(JL)                                           MAIN5880
      X(68) = X(68)+FLOAT(IL)                                           MAIN5890
      PC1 = FLOAT(JL)                                                   MAIN5900
      P2 = (PC1/FLOAT(IK))*100.                                         MAIN5910
      PC2 = FLOAT(IL)                                                   MAIN5920
      P3 = (PC2/FLOAT(IK))*100.                                         MAIN5930
      WRITE (6,1370) IK,JL,P2,IL,P3                                     MAIN5940
      GO TO 780                                                         MAIN5950
  770 WRITE (6,1060)                                                    MAIN5960
  780 IT = IFIX(X(13)+AMF)                                              MAIN5970
      WRITE (6,1380) IT                                                 MAIN5980
      X(14) = X(14)+X(13)                                               MAIN5990
      X(13) = 0.                                                        MAIN6000
C                                                                       MAIN6010
C            DO THE SUMMARY STATISITICS FOR ITERATIONS COMPLETED        MAIN6020
C                                                                       MAIN6030
      WRITE (6,1390) KOUNT                                              MAIN6040
      IM = IFIX(X(61)+AMF)                                              MAIN6050
      IMF = IFIX(X(65)+AMF)                                             MAIN6060
      IM = IM-IMF                                                       MAIN6070
      IF (IM.GT.0) GO TO 790                                            MAIN6080
      PC1 = 0.                                                          MAIN6090
      PC2 = 0.                                                          MAIN6100
      PC3 = 0.                                                          MAIN6110
      IMK = 0                                                           MAIN6120
      IML = 0                                                           MAIN6130
      GO TO 800                                                         MAIN6140
  790 PC1 = (X(62)/FLOAT(IM))*100.                                      MAIN6150
      PW = FLOAT(IM)-X(62)                                              MAIN6160
      IMK = IFIX(X(63)+AMF)                                             MAIN6170
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      PC2 = (X(63)/PW)*100.                                             MAIN6180
      IML = IFIX(X(64)+AMF)                                             MAIN6190
      PC3 = (X(64)/PW)*100.                                             MAIN6200
  800 ILF = IFIX(X(62)+AMF)                                             MAIN6210
      PC4 = (X(65)/X(61))*100.                                          MAIN6220
      WRITE (6,1350) IM,ILF,PC1,IMK,PC2,IML,PC3                         MAIN6230
      WRITE (6,1360) IMF,PC4                                            MAIN6240
      HITS = X(70)/FLOAT(KOUNT)                                         MAIN6250
      WRITE (6,1400) KOUNT,HITS                                         MAIN6260
      IF (X(66).EQ.0.) GO TO 810                                        MAIN6270
      IP = IFIX(X(66)+AMF)                                              MAIN6280
      IP1 = IFIX(X(67)+AMF)                                             MAIN6290
      IP2 = IFIX(X(68)+AMF)                                             MAIN6300
      PC1 = (X(67)/X(66))*100.                                          MAIN6310
      PC2 = (X(68)/X(66))*100.                                          MAIN6320
      WRITE (6,1370) IP,IP1,PC1,IP2,PC2                                 MAIN6330
  810 IT = IFIX(X(14)+AMF)                                              MAIN6340
      WRITE (6,1380) IT                                                 MAIN6350
      WRITE (6,1410) KOUNT                                              MAIN6360
      WRITE (6,1420)                                                    MAIN6370
      WRITE (6,1430) (L,(JACK(L,ND),ND=1,7),L=1,NS)                     MAIN6380
      WRITE (6,1080)                                                    MAIN6390
C                                                                       MAIN6400
      DO 860 L=1,NS                                                     MAIN6410
      IF (JACK(L,5).EQ.0) GO TO 820                                     MAIN6420
      USC = STATS(L,1)/FLOAT(JACK(L,5))                                 MAIN6430
      GO TO 830                                                         MAIN6440
  820 USC = 0.                                                          MAIN6450
  830 IF (JACK(L,7).EQ.0) GO TO 840                                     MAIN6460
      PC1 = STATS(L,2)/FLOAT(JACK(L,7))                                 MAIN6470
      GO TO 850                                                         MAIN6480
  840 PC1 = 0.                                                          MAIN6490
  850 WRITE (6,1090) L,USC,PC1                                          MAIN6500
  860 CONTINUE                                                          MAIN6510
C                                                                       MAIN6520
      WRITE (6,1070) IFAG,IFBG                                          MAIN6530
      WRITE (6,1100)                                                    MAIN6540
C                                                                       MAIN6550
      DO 870 L=1,NS                                                     MAIN6560
      WRITE (6,1110) L,ISAG(L),ISBG(L)                                  MAIN6570
  870 CONTINUE                                                          MAIN6580
C                                                                       MAIN6590
      WRITE (6,1120)                                                    MAIN6600
C                                                                       MAIN6610
      DO 880 L=1,NS                                                     MAIN6620
      WRITE (6,1130) L,IHIT(L)                                          MAIN6630
  880 CONTINUE                                                          MAIN6640
C                                                                       MAIN6650
```

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C                                                                       MAIN6660
      DO 890 L=1,NS                                                     MAIN6670
      IJ = IHIT(L)                                                      MAIN6680
      MARY(IJ) = MARY(IJ)+1                                             MAIN6690
  890 CONTINUE                                                          MAIN6700
C                                                                       MAIN6710
      IF (X(85).EQ.0.) GO TO 920                                        MAIN6720
      L = IFIX(X(85)+AMF)                                               MAIN6730
      HISX(I) = FLOAT(IHIT(L))                                          MAIN6740
      TMA = 0.                                                          MAIN6750
      TMIN = 10000.                                                     MAIN6760
C                                                                       MAIN6770
      DO 900 LL=1,NASM                                                  MAIN6780
      IF (ASMT(LL,1).NE.4.) GO TO 900                                   MAIN6790
      IF (ASMT(LL,4).NE.X(85)) GO TO 900                                MAIN6800
      IF (ASMT(LL,2).LT.TMIN) TMIN=ASMT(LL,2)                           MAIN6810
      IF (ASMT(LL,2).GT.TMA) TMA=ASMT(LL,2)                             MAIN6820
  900 CONTINUE                                                          MAIN6830
C                                                                       MAIN6840
      IF (HISX(I).LE.1.) GO TO 910                                      MAIN6850
      HISA(I) = TMA-TMIN                                                MAIN6860
      HISO(I) = HISX(I)/HISA(I)                                         MAIN6870
      GO TO 920                                                         MAIN6880
  910 HISO(I) = 0.                                                      MAIN6890
      HISA(I) = 0.                                                      MAIN6900
  920 IF (KOUNT.GT.1) GO TO 980                                         MAIN6910
      IJ = IFIX(X(51)+AMF)                                              MAIN6920
      IF (IJ.EQ.0) GO TO 930                                            MAIN6930
      WRITE (6,1440) (L,(SHIP(L,J),J=1,6),L=1,NS)                       MAIN6940
  930 IJ = IFIX(X(52)+AMF)                                              MAIN6950
      IF (IJ.EQ.0) GO TO 940                                            MAIN6960
      WRITE (6,1450) (L,(RAID(L,J),J=1,13),L=1,NR)                      MAIN6970
  940 IJ = IFIX(X(53)+AMF)                                              MAIN6980
      IF (IJ.EQ.0) GO TO 950                                            MAIN6990
      WRITE (6,1460)                                                    MAIN7000
      WRITE (6,1470) (L,(SMAT(L,J),J=1,10),L=1,NSAM)                    MAIN7010
  950 IJ = IFIX(X(54)+AMF)                                              MAIN7020
      IF (IJ.EQ.0) GO TO 970                                            MAIN7030
      X(54) = 0.                                                        MAIN7040
      WRITE (6,1480)                                                    MAIN7050
      IS = IFIX(X(14)+AMF)                                              MAIN7060
C                                                                       MAIN7070
      DO 960 L=1,IS                                                     MAIN7080
      CALL RANDOM (INSECT,Z,1)                                          MAIN7090
      WRITE (6,1490) Z                                                  MAIN7100
  960 CONTINUE                                                          MAIN7110
C                                                                       MAIN7120
  970 X(55) = 0.                                                        MAIN7130
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      X(9) = 0.                                                          MAIN7140
      X(53) = 0.                                                         MAIN7150
      X(52) = 0.                                                         MAIN7160
      X(56) = 0.                                                         MAIN7170
      X(57) = 0.                                                         MAIN7180
      X(58) = 0.                                                         MAIN7190
      X(59) = 0.                                                         MAIN7200
      X(60) = 0.                                                         MAIN7210
  980 X(75) = FLOAT(NMIF)                                                MAIN7220
      WRITE (6,1500)                                                     MAIN7230
  990 CONTINUE                                                           MAIN7240
C                                                                        MAIN7250
      WRITE (6,1140)                                                     MAIN7260
      WRITE (6,1150)                                                     MAIN7270
C                                                                        MAIN7280
      DO 1000 I=1,10                                                     MAIN7290
      IN = I+10                                                          MAIN7300
      IT = I+20                                                          MAIN7310
      IS = I+30                                                          MAIN7320
      IY = I+40                                                          MAIN7330
      IJ = I+50                                                          MAIN7340
      LA = I+60                                                          MAIN7350
      IO = I+70                                                          MAIN7360
      IG = I+80                                                          MAIN7370
      JC = I+90                                                          MAIN7380
      WRITE (6,1160) I,MARY(I),IN,MARY(IN),IT,MARY(IT),IS,MARY(IS),IY,MAMAIN7390
     1RY(IY),IJ,MARY(IJ),LA,MARY(LA),IO,MARY(IO),IG,MARY(IG),JC,MARY(JC)MAIN7400
 1000 CONTINUE                                                           MAIN7410
C                                                                        MAIN7420
      IF (X(85).EQ.0.) GO TO 1010                                        MAIN7430
      CALL HISTG (HISX,NI,0)                                             MAIN7440
      WRITE (6,1030) X(85)                                               MAIN7450
      CALL HISTG (HISA,NI,0)                                             MAIN7460
      WRITE (6,1040) X(85)                                               MAIN7470
      CALL HISTG (HISO,NI,0)                                             MAIN7480
      WRITE (6,1050) X(85)                                               MAIN7490
      WRITE (7,1020) HISO                                                MAIN7500
 1010 STOP                                                               MAIN7510
C                                                                        MAIN7520
 1020 FORMAT (F8.3)                                                      MAIN7530
 1030 FORMAT (40X,'HIT FREQUENCY ANALYSIS FOR SHIP',F4.0)                MAIN7540
 1040 FORMAT (40X,'ASM/SSM ARRIVAL TIME INTERVAL ANALYSIS FOR SHIP',F4.0MAIN7550
     1)                                                                  MAIN7560
 1050 FORMAT (' ',25X,'HITS PER MINUTE ON SHIP',F3.0)                    MAIN7570
 1060 FORMAT ('  NO SAMS FIRED')                                         MAIN7580
 1070 FORMAT ('0',I6,' ASMS WERE FIRED ON BY THE FLEET'/(I7,' BOMBERS WEMAIN7590
     1RE FIRED ON BY THE FLEET'))                                        MAIN7600
 1080 FORMAT ('0','SHIP    AVE DET RANGE    AVE DET RANGE'/(12X,'BOMBERS',MAIN7610
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     110X,'ASMS'/))                                                     MAIN7620
 1090 FORMAT (' ',I3,7X,F9.2,7X,F9.2)                                   MAIN7630
 1100 FORMAT ('0','SHIP   ASMS FIRED AT    BOMBERS FIRED AT'/)          MAIN7640
 1110 FORMAT (I4,I13,I19)                                               MAIN7650
 1120 FORMAT ('0','                              HITS ON SHIP "I"')     MAIN7660
 1130 FORMAT (I6,I5)                                                    MAIN7670
 1140 FORMAT ('0',47X,'FINAL STATISTICS'/(' ',10('NO. OF',6X)))         MAIN7680
 1150 FORMAT (' ',10('HITS FREQ. '))                                    MAIN7690
 1160 FORMAT (' ',10(I4,I6,1X))                                         MAIN7700
 1170 FORMAT (I10,5F10.3)                                               MAIN7710
 1180 FORMAT ('1',45X,'THE X ARRAY AFTER CONVERSION'//,8(' ADR  CONTENT MAIN7720
     1 '))                                                              MAIN7730
 1190 FORMAT ('1',48X,'THE X ARRAY AS READ IN'//,8(' ADR  CONTENT  '))  MAIN7740
 1200 FORMAT (8(I5,F10.2))                                              MAIN7750
 1210 FORMAT (30I2)                                                     MAIN7760
 1220 FORMAT (9(I3,I2,5X))                                              MAIN7770
 1230 FORMAT (10F8.4)                                                   MAIN7780
 1240 FORMAT ('0',39X,'THE TARGET LISTS'/(6('  SHIP C-PROB  ')))        MAIN7790
 1250 FORMAT (6(I5,F7.4,2X))                                            MAIN7800
 1260 FORMAT ('0','   NMIF IS',I6)                                      MAIN7810
 1270 FORMAT ('1','THE NUMBER OF SAMS LEFT AT THE END OF ITERATION',I3,'MAIN7820
     1 WAS',I5//)                                                       MAIN7830
 1280 FORMAT ('0',55X,'ASM TABLE'/(55X,'ITERATION ',I2//(26X,'ASM     STMAIN7840
     1ATUS TIME OF  LAUNCH  TARGET  LAUNCH  WEAPON     X      Y'))))    MAIN7850
 1290 FORMAT (' ',24X,'NUMBER   CODE   IMPACT   RAID   SHIP   TIME   CMAIN7860
     1LASS   LAUNCH  LAUNCH'/)                                          MAIN7870
 1300 FORMAT ('0',25X,I3,F6.0,F8.3,2F8.0,F9.2,F6.0,2F10.2)              MAIN7880
 1310 FORMAT ('0',/(' ','THE ORIGINAL ATTACK CONSISTED OF',I3,' RAIDERS.MAIN7890
     1',I3,' WERE LEFT AFTER THE ATTACK.'/))                            MAIN7900
 1320 FORMAT ('0',49X,'SAM-ASM-RAID TABLE'/(21X,'TGT NO.   LAUNCHER    MAIN7910
     1 CHANNEL   TIME OF LAUNCH    KILL CODE    TIME CHANNEL FREE'/))   MAIN7920
 1330 FORMAT (20X,F7.0,F10.0,F12.0,F16.2,F14.0,F21.2)                   MAIN7930
 1340 FORMAT ('1',10X,'STATISTICS FOR ITERATION NO.',I4//(20X,'THE SHIPSMAIN7940
     1 TOOK',I5,' HITS.'))                                              MAIN7950
 1350 FORMAT (20X,'OF',I5,' ASMS FIRED,',I5,' (',F6.2,' PERCENT) FAILED MAIN7960
     1AT LAUNCH,'/(20X,'OF LAUNCHED ASM,',I5,' (',F6.2,' PERCENT) WERE KMAIN7970
     2ILLED BY SAMS,'/(38X,I5,' (',F6.2,' PERCENT) FAILED IN FLIGHT.')))MAIN7980
 1360 FORMAT (' ',20X,'OF THE TOTAL ASMS AVAIL,',I5,' (',F6.2,' PERCENT)MAIN7990
     1 WERE DESTROYED WHEN'/(62X,'MOTHER KILLED BY SAMS.'))             MAIN8000
 1370 FORMAT ('0',16X,I4,' SAMS WERE LAUNCHED OF WHICH ',I4,' (',F6.2,' MAIN8010
     1PERCENT) FAILED AND'/(50X,I4,' (',F6.2,' PERCENT) WERE OVERKILLS.'MAIN8020
     2))                                                                MAIN8030
 1380 FORMAT ('0'////(12X,I8,' RANDOM NUMBERS WERE DRAWN.'//))          MAIN8040
 1390 FORMAT ('0','SUMMARY FOR',I3,' ITERATIONS')                       MAIN8050
 1400 FORMAT ('0'//(20X,'AVERAGE NUMBER OF HITS ON FLEET FOR',I3,' ITERAMAIN8060
     1TIONS IS',F6.2//))                                                MAIN8070
 1410 FORMAT ('0',19X,'SHIP STATS FOR ITERATION',I3)                    MAIN8080
 1420 FORMAT (' '/(' SHIP   CHANCES    NUMBER OF    TARGETS   BOMBERS   MAIN8090
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     1    BOMBERS   ASMS',9X,'ASMS'/('  NO.    TO ENGAGE  ENGAGEMENTS   MAIN8100
     2KILLED     DETECTABLE   DETECTED   DETECTABLE   DETECTED'/)))     MAIN8110
 1430 FORMAT (' ',I4,I10,I11,I13,I10,I13,I9,I11)                        MAIN8120
 1440 FORMAT ('0','SHIP   CLASS      X         Y     HITS TO SINK  CLA-ADRMAIN8130
     1    UP/DOWN'//(I4,F7.0,F10.2,F10.2,F9.0,F12.0,F11.0))             MAIN8140
 1450 FORMAT (' '//,' RAIDER CLASS   TIMER(R)    XR       YR        XEOG   YMAIN8150
     1EOG    XL       YL     ALT       HORZ  WEP-CLASS  WEPS  UP/DOWN'/(' ',MAIN8160
     2I3,F10.0,F9.2,F7.1,3F8.1,2F7.1,F8.1,F7.0,F10.0,F8.0,F7.0))        MAIN8170
 1460 FORMAT (' '//(5X,'SAM   SAM CLASS INDEX   SHIP NUMBER   SAM LEFT  MAIN8180
     1 CH1 FREE   CH2 FR   CH3 FR   CH4 FR   CH5 FR   CH6 FR   SALVO')) MAIN8190
 1470 FORMAT (' ',4X,I3,F13.0,F17.0,F11.0,2F11.2,4F9.2,F8.0)            MAIN8200
 1480 FORMAT ('  RANDOM NUMBERS USED IN ITERATION ONE.'/)               MAIN8210
 1490 FORMAT (F8.4)                                                      MAIN8220
 1500 FORMAT ('1')                                                       MAIN8230
      END                                                                MAIN8240


      SUBROUTINE EFFECT                                                  EFT   10
C                                                                        EFT   20
C          THIS SUBROUTINE CONTROLS EACH ITERATION                       EFT   30
C                                                                        EFT   40
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMEFT   50
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEEEFT   60
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOEFT   70
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QEFT   80
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),EFT   90
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4EFT  100
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             EFT  110
      IJ = X(55)                                                         EFT  120
      IF (IJ.EQ.0) GO TO 20                                              EFT  130
      CALL GETIMX (IET)                                                  EFT  140
      TIMES = IET*.000026                                                EFT  150
      WRITE (6,130) TIMES                                                EFT  160
   20 CALL JULIE                                                         EFT  170
   30 CALL GETEV (TIME,NEXTEV,IUNIT)                                     EFT  180
      IF (NEXTEV.EQ.0) GO TO 100                                         EFT  190
      IF (NEXTEV.GT.6) GO TO 120                                         EFT  200
      GO TO (40,50,60,70,80,90), NEXTEV                                  EFT  210
   40 CALL SUBE1 (TIME,IUNIT)                                            EFT  220
      GO TO 30                                                           EFT  230
   50 CALL SUBE2 (TIME,IUNIT)                                            EFT  240
      GO TO 30                                                           EFT  250
   60 CALL SUBE3 (TIME,IUNIT)                                            EFT  260
      GO TO 30                                                           EFT  270
   70 CALL SUBE4 (IUNIT)                                                 EFT  280
      GO TO 30                                                           EFT  290
   80 CALL SUBE5 (IUNIT)                                                 EFT  300
      GO TO 30                                                           EFT  310
```

```
   90 CALL SUBE6 (IUNIT)                                                EFT  320
      GO TO 30                                                          EFT  330
  100 IF (IJ.EQ.0) GO TO 110                                            EFT  340
      CALL GETIMX (IET)                                                 EFT  350
      TIMES = IET*.000026                                               EFT  360
      WRITE (6,140) TIMES                                               EFT  370
  110 RETURN                                                            EFT  380
  120 WRITE (6,150) NEXTEV                                              EFT  390
      STOP                                                              EFT  400
C                                                                       EFT  410
  130 FORMAT ('0',' EFFECT LOGIN AT ',F11.7)                            EFT  420
  140 FORMAT ('0',' EFFECT LOGOUT AT',F11.7)                            EFT  430
  150 FORMAT ('0','**  NON-EXISTENT EVENT CALLED **** TYPE ',I3)        EFT  440
      END                                                               EFT  450


      SUBROUTINE JULIE                                                  JLE   10
C                                                                       JLE   20
C         THIS SUBROUTINE INITIALIZES  OR RESETS ITEMS REQUIRED         JLE   30
C         TO BE RESET FOR EACH ITERATICN.                               JLE   40
C                                                                       JLE   50
      REAL *8RAT,BNG,RAN                                                JLE   60
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMJLE   70
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEEJLE   80
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOJLE   90
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QJLE  100
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),JLE  110
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4JLE  120
     60),AMF,HISX(100),JACK(40,7),HISA(100)                            JLE  130
      IF (X(55).EQ.0.) GO TO 20                                         JLE  140
      CALL GETIMX (IET)                                                 JLE  150
      TIMES = IET*.000026                                               JLE  160
      WRITE (6,530) TIMES                                               JLE  170
   20 CALL EVENT                                                        JLE  180
      IFIRST = 0                                                        JLE  190
      NASM = 0                                                          JLE  200
      IFLASK = 0                                                        JLE  210
      ITEMS = 0                                                         JLE  220
      NSAM = 0                                                          JLE  230
      IFAG = 0                                                          JLE  240
      IFBG = 0                                                          JLE  250
C                                                                       JLE  260
C       SET CHANNEL ARRAY TO ZERO                                       JLE  270
C                                                                       JLE  280
      DO 60 I=1,NS                                                      JLE  290
C                                                                       JLE  300
      DO 50 J=1,4                                                       JLE  310
C                                                                       JLE  320
```

```
      DO 40 K=1,3
C
      DO 30 L=1,6
      CHANEL(I,J,K,L) = 0.
   30 CONTINUE
C
   40 CONTINUE
C
   50 CONTINUE
C
   60 CONTINUE
C
C            SET JAM ARRAY TO ZERO
C
      DO 70 I=1,4
      JAM(I) = 0
   70 CONTINUE
C
C
      DO 100 I=1,NS
      IHIT(I) = 0
      ISAG(I) = 0
      ISBG(I) = 0
C
      DO 80 J=1,7
      JACK(I,J) = 0
   80 CONTINUE
C
C
      DO 90 J=1,2
      STATS(I,J) = 0.
   90 CONTINUE
C
  100 CONTINUE
C
C
      DO 120 I=1,190
      TGTAV(I) = 0.
      IGAGE(I) = 0
C
      DO 110 J=1,40
      NONO(I,J) = 0
  110 CONTINUE
C
  120 CONTINUE
C
C
      DO 140 I=1,300
```

```
C                                                                       JLE  810
      DO 130 J=1,7                                                      JLE  820
      SAMASM(I,J) = 0.                                                  JLE  830
  130 CONTINUE                                                          JLE  840
C                                                                       JLE  850
  140 CONTINUE                                                          JLE  860
C                                                                       JLE  870
C           RESET RAID TABLE                                            JLE  880
C                                                                       JLE  890
      DO 150 I=1,NR                                                     JLE  900
      IOR = IFIX(RAID(I,1)+AMF)                                         JLE  910
      MISLFT(I,1) = IFIX(X(IOR+2)+AMF)                                  JLE  920
      MISLFT(I,2) = IFIX(X(IOR+4)+AMF)                                  JLE  930
      IF (X(IOR+9).GT.0.) JAM(1)=JAM(1)+1                               JLE  940
      IF (X(IOR+10).GT.0.) JAM(2)=JAM(2)+1                              JLE  950
      IF (X(IOR+11).GT.0.) JAM(3)=JAM(3)+1                              JLE  960
      IF (X(IOR+12).GT.0.) JAM(4)=JAM(4)+1                              JLE  970
      RAID(I,13) = X(IOR+1)                                             JLE  980
      RAID(I,2) = 0.                                                    JLE  990
      RAN = DBLE(X(2202+(I-1)*6))                                       JLE 1000
      BNG = DBLE(X(2203+(I-1)*6))                                       JLE 1010
      RAT = RADIAN(BNG)                                                 JLE 1020
      RAID(I,3) = RAN*DCOS(RAT)                                         JLE 1030
      RAID(I,4) = RAN*DSIN(RAT)                                         JLE 1040
      RAID(I,14) = RAID(I,5)                                            JLE 1050
      RAID(I,15) = RAID(I,6)                                            JLE 1060
      RAID(I,17) = 1000.                                                JLE 1070
  150 CONTINUE                                                          JLE 1080
C                                                                       JLE 1090
C           RESET SHIP TABLE                                            JLE 1100
C                                                                       JLE 1110
      DO 180 I=1,NS                                                     JLE 1120
      ID = IFIX(SHIP(I,1)+AMF)                                          JLE 1130
      IID = (ID-1)*40                                                   JLE 1140
      SHIP(I,4) = X(121+IID)                                            JLE 1150
      IJ = IFIX(X(101+IID)+AMF)                                         JLE 1160
      IF (IJ.EQ.0) GO TO 180                                            JLE 1170
      SHIP(I,6) = 1.                                                    JLE 1180
C                                                                       JLE 1190
      DO 160 K=1,4                                                      JLE 1200
      IJ = IFIX(X(100+K+IID)+AMF)                                       JLE 1210
      IF (IJ.EQ.0) GO TO 170                                            JLE 1220
      IBAT(I,K) = IFIX(X(527+(IJ-1)*40)+AMF)                            JLE 1230
  160 CONTINUE                                                          JLE 1240
C                                                                       JLE 1250
  170 IF (X(58).EQ.0.) GO TO 180                                        JLE 1260
      WRITE (6,540) (I,(IBAT(I,J),J=1,K))                               JLE 1270
  180 CONTINUE                                                          JLE 1280
```

```
C                                                                       JLE 1290
C                                                                       JLE 1300
      DO 200 I=1,300                                                    JLE 1310
C                                                                       JLE 1320
      DO 190 J=1,10                                                     JLE 1330
      SMAT(I,J) = 0.                                                    JLE 1340
  190 CONTINUE                                                          JLE 1350
C                                                                       JLE 1360
  200 CONTINUE                                                          JLE 1370
C                                                                       JLE 1380
      IF (X(2).EQ.0.) GO TO 450                                         JLE 1390
C                                                                       JLE 1400
C            IF THE FLAG IS SET, THE AVAILABILITY OF ALL RADARS AND     JLE 1410
C            LAUNCHERS IS DETERMINED FOR EACH ITERATION.  IF ALL        JLE 1420
C            SEARCH RADARS ARE DOWN, THE ROUTINE CHECKS TO SEE IF       JLE 1430
C            THE FIRE CONTROL RADARS ARE HORIZON SEARCH CAPABEL. AT     JLE 1440
C            THIS TIME IT WILL ALSO CHECK TO SEE IF THE MISSILES ARE    JLE 1450
C            PASSIVE (HOJ OR ARM) OR IF THEY REQUIRE A REMOTE ILLUM-    JLE 1460
C            INATOR.                                                    JLE 1470
C                                                                       JLE 1480
C          DOES SHIP I HAVE A MISSILE SYSTEM?  NO GO TO 540             JLE 1490
C                                                                       JLE 1500
      DO 440 I=1,NS                                                     JLE 1510
      IF (SHIP(I,6).EQ.0.) GO TO 440                                    JLE 1520
      IS = IFIX(SHIP(I,5)+AMF)                                          JLE 1530
      IFOG = 0                                                          JLE 1540
      WRITE (6,550) I                                                   JLE 1550
      KFOG = 0                                                          JLE 1560
C                                                                       JLE 1570
C          CHECK FOR AT LEAST ONE UP SEARCH RADAR                       JLE 1580
C                                                                       JLE 1590
      DO 220 J=4,6                                                      JLE 1600
      K = J-3                                                           JLE 1610
      IT = IFIX(X(IS+J)+AMF)                                            JLE 1620
      IF (IT.EQ.0) GO TO 230                                            JLE 1630
      PROB = X(913+(IT-1)*20)                                           JLE 1640
      CALL RANDOM (ISEED,Z,1)                                           JLE 1650
      X(13) = X(13)+1.                                                  JLE 1660
      IF (Z.GT.PROB) GO TO 210                                          JLE 1670
      KFOG = 1                                                          JLE 1680
      WRITE (6,560) K                                                   JLE 1690
      NADAR(I,K) = 1                                                    JLE 1700
      GO TO 220                                                         JLE 1710
  210 WRITE (6,570) K                                                   JLE 1720
      NADAR(I,K) = 0                                                    JLE 1730
  220 CONTINUE                                                          JLE 1740
C                                                                       JLE 1750
  230 IF (KFOG.EQ.1) GO TO 270                                          JLE 1760
```

```
C                                                                       JLE 1770
      DO 240 J=1,4                                                      JLE 1780
      IP = IFIX(X(IS+J-1)+AMF)                                          JLE 1790
      IF (IP.EQ.0) GO TO 260                                            JLE 1800
      IC = IFIX(X(518+(IP-1)*40)+AMF)                                   JLE 1810
      IF (IC.NE.0) GO TO 250                                            JLE 1820
  240 CONTINUE                                                          JLE 1830
C                                                                       JLE 1840
  250 IF (X(7).EQ.1.) GO TO 270                                         JLE 1850
  260 SHIP(I,6) = 0.                                                    JLE 1860
      GO TO 440                                                         JLE 1870
C                                                                       JLE 1880
  270 DO 390 J=1,4                                                      JLE 1890
      IP = X(IS+J-1)                                                    JLE 1900
      IF (IP.EQ.0) GO TO 390                                            JLE 1910
C                                                                       JLE 1920
      DO 330 L=1,3                                                      JLE 1930
      IA = IFIX(X(516+(IP-1)*40+2*L)+AMF)                               JLE 1940
      IF (IA.GT.0) GO TO 300                                            JLE 1950
      GO TO (280,390,390), L                                            JLE 1960
  280 IFOG = 1                                                          JLE 1970
      WRITE (6,580) J                                                   JLE 1980
C                                                                       JLE 1990
      DO 290 LK=1,3                                                     JLE 2000
      NADAR(I,(3+(J-1)*3+LK))=2                                         JLE 2010
  290 CONTINUE                                                          JLE 2020
C                                                                       JLE 2030
      GO TO 390                                                         JLE 2040
  300 PROB = X(913+(IA-1)*20)                                           JLE 2050
      CALL RANDOM (ISEED,Z,1)                                           JLE 2060
      X(13) = X(13)+1.                                                  JLE 2070
      IF (PROB.GT.Z) GO TO 320                                          JLE 2080
  310 NADAR(I,(3+(J-1)*3+L))=0                                          JLE 2090
      WRITE (6,590) L,J                                                 JLE 2100
      GO TO 330                                                         JLE 2110
  320 IF (KFOG.EQ.0) GO TO 330                                          JLE 2120
      NADAR(I,(3+(J-1)*3+L))=1                                          JLE 2130
      WRITE (6,600) L,J                                                 JLE 2140
      IFOG = 1                                                          JLE 2150
      GO TO 380                                                         JLE 2160
  330 ID = IFIX(X(523+(IP-1)*40)+AMF)                                   JLE 2170
      GO TO (340,350,360), L                                            JLE 2180
  340 IF (ID.EQ.1.OR.ID.EQ.11.OR.ID.EQ.101.OR.ID.EQ.111) GO TO 370      JLE 2190
      GO TO 310                                                         JLE 2200
  350 IF (ID.EQ.10.OR.ID.EQ.11.OR.ID.EQ.110.OR.ID.EQ.111) GO TO 370     JLE 2210
      GO TO 310                                                         JLE 2220
  360 IF (ID.EQ.100.OR.ID.EQ.101.OR.ID.EQ.110.OR.ID.EQ.111) GO TO 370   JLE 2230
      GO TO 310                                                         JLE 2240
```

```
  370 IFOG = 1                                                          JLE 2250
      WRITE (6,610) L,J                                                 JLE 2260
      NADAR(I,(3+(J-1)*3+L))=3                                          JLE 2270
  380 CONTINUE                                                          JLE 2280
C                                                                       JLE 2290
  390 CONTINUE                                                          JLE 2300
C                                                                       JLE 2310
      IF (KFOG.EQ.1.OR.IFOG.EQ.1) GO TO 400                             JLE 2320
      SHIP(I,6) = 0.                                                    JLE 2330
      WRITE (6,620)                                                     JLE 2340
      GO TO 440                                                         JLE 2350
  400 IFOG = 0                                                          JLE 2360
C                                                                       JLE 2370
C           DETERMINE LAUNCHER STATUS                                   JLE 2380
C                                                                       JLE 2390
      DO 420  J=1,4                                                     JLE 2400
      IP = IFIX(X(IS+J-1)+AMF)                                          JLE 2410
      IF (IP.EQ.0) GO TO 430                                            JLE 2420
      PROB = X(526+(IP-1)*40)                                           JLE 2430
      CALL RANDOM (ISEED,Z,1)                                           JLE 2440
      X(13) = X(13)+1.                                                  JLE 2450
      IF (PROB.GT.Z) GO TO 410                                          JLE 2460
      NADAR(I,(15+J)) = 0                                               JLE 2470
      WRITE (6,630) J                                                   JLE 2480
      GO TO 420                                                         JLE 2490
  410 IFOG = 1                                                          JLE 2500
      NADAR(I,(15+J)) = 1                                               JLE 2510
      WRITE (6,640) J                                                   JLE 2520
  420 CONTINUE                                                          JLE 2530
C                                                                       JLE 2540
  430 IF (IFOG.EQ.1) GO TO 440                                          JLE 2550
      SHIP(I,6) = 0.                                                    JLE 2560
      WRITE (6,620)                                                     JLE 2570
  440 CONTINUE                                                          JLE 2580
C                                                                       JLE 2590
C                                                                       JLE 2600
  450 DO 460  I=1,NR                                                    JLE 2610
      CALL STOREV (0.,1,I)                                              JLE 2620
      ID = IFIX(RAID(I,11)+AMF)                                         JLE 2630
      IF (ID.EQ.0) GO TO 460                                            JLE 2640
      RGE = X(2003+(ID-1)*10)                                           JLE 2650
      CALL TMDBOM (I,RGE,T)                                             JLE 2660
      CALL STOREV (T,2,I)                                               JLE 2670
      IF (X(60).EQ.0.) GO TO 460                                        JLE 2680
      WRITE (6,650)                                                     JLE 2690
      WRITE (6,660) (LOP,(IVENTS(LOP,J),J=1,2),LOP=1,LOVER)             JLE 2700
  460 CONTINUE                                                          JLE 2710
C                                                                       JLE 2720
```

```
      MAMBAT = 0                                                        JLE 2730
C                                                                       JLE 2740
      DO 480 I=1,NS                                                     JLE 2750
C                                                                       JLE 2760
      DO 470 J=16,19                                                    JLE 2770
      MAMBAT = MAMBAT+NADAR(I,J)                                        JLE 2780
  470 CONTINUE                                                          JLE 2790
C                                                                       JLE 2800
  480 CONTINUE                                                          JLE 2810
C                                                                       JLE 2820
C                                                                       JLE 2830
      DO 500 I=1,NS                                                     JLE 2840
C                                                                       JLE 2850
      DO 490 J=1,4                                                      JLE 2860
      RELOAD(I,J) = 0.                                                  JLE 2870
  490 CONTINUE                                                          JLE 2880
C                                                                       JLE 2890
  500 CONTINUE                                                          JLE 2900
C                                                                       JLE 2910
      IF (X(60).EQ.0.) GO TO 510                                        JLE 2920
      WRITE (6,650)                                                     JLE 2930
      WRITE (6,660) (I,(IVENTS(I,J),J=1,2),I=1,LOVER)                   JLE 2940
  510 IF (X(55).EQ.0.) GO TO 520                                        JLE 2950
      CALL GETIMX (IET)                                                 JLE 2960
      TIMES = IET*.000026                                               JLE 2970
      WRITE (6,670) TIMES                                               JLE 2980
  520 RETURN                                                            JLE 2990
C                                                                       JLE 3000
  530 FORMAT ('0','   JULIE CALLED AT',F15.5)                           JLE 3010
  540 FORMAT ('0'/(17X,'IBAT TABLE'//(' ',5I10)))                       JLE 3020
  550 FORMAT ('0','  EQUIPMENT STATS FOR SAM SHIP ',I3)                 JLE 3030
  560 FORMAT (' ','  RADAR ',I2,' UP')                                  JLE 3040
  570 FORMAT (' ',' RADAR ',I2,' DOWN')                                 JLE 3050
  580 FORMAT ('      SYSTEM',I2,' REQUIRES NO DEDICATED FC RADAR')      JLE 3060
  590 FORMAT (' ',' FC RADAR',I2,' SYSTEM',I2,' DOWN.')                 JLE 3070
  600 FORMAT (' ',' FC RADAR',I2,' SYSTEM',I2,' UP.')                   JLE 3080
  610 FORMAT (' ',' FC RADAR',I2,' SYSTEM',I2,' OPERATING IN HORIZON SEAJLE 3090
     1RCH MODE.')                                                       JLE 3100
  620 FORMAT ('       SHIP DESIG NON-COMBAT DUE TO DOWN EQUIPMENT.')    JLE 3110
  630 FORMAT ('      LAUNCHER',I2,' DOWN.')                             JLE 3120
  640 FORMAT ('      LAUNCHER',I2,' UP.')                               JLE 3130
  650 FORMAT ('         EVENTS LIST'/('   SLOT     TIME         CODE'))  JLE 3140
  660 FORMAT (I7,I12,I13)                                               JLE 3150
  670 FORMAT ('0','  JULIE OUT AT',F15.8)                               JLE 3160
      END                                                               JLE 3170

      SUBROUTINE EVENT                                                  EVT   10
```

```
C
C          THIS SUBROUTINE PUTS THE END OF GAME TIME IN THE
C          EVENTS LIST AFTER ZEROING OUT THE OLD LISTING.
C
      REAL *8HOTDOG
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SM
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEE
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASO
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,Q
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4
     60),AMF,HISX(100),JACK(40,7),HISA(100)
      IQ = X(55)
      IF (IQ.EQ.0) GO TO 20
      CALL GETIMX (IET)
      TIMES = IET*.000026
      WRITE (6,210) TIMES
   20 LOVER = 1
C
C
C
      DO 40 I=1,1000
C
      DO 30 J=1,2
      IVENTS(I,J) = 0
   30 CONTINUE
C
   40 CONTINUE
C
      T = X(82)
      IT = 1000*(T+.0005)
      IVENTS(1,2) = 0
      IVENTS(1,1) = IT
      IF (IQ.EQ.0) GO TO 50
      CALL GETIMX (IET)
      TIMES = IET*.000026
      WRITE (6,220) TIMES
   50 RETURN
C
      ENTRY GETEV(TIME,NEXTEV,IUNIT)
C
C          THIS ENTRY GETS THE NEXT EVENT FROM THE EVENTS LIST AND
C          CONVERTS IT INTO:
C             (A)  TIME..........THE TIME OF THE EVENT
C             (B)  NEXTEV........THE TYPE OF NEXT EVENT
C             (C)  IUNIT.........THE UNITS INVOLVED IN THE NEXT EVENT
C
      IF (X(55).EQ.0.) GO TO 60
```

```
      CALL GETIMX (IET)                                                 EVT  500
      TIMES = IET*.000026                                               EVT  510
      WRITE (6,230) TIMES                                               EVT  520
   60 ITIM = IVENTS(1,1)                                                EVT  530
      IVET = IVENTS(1,2)                                                EVT  540
      HOTDOG = DFLOAT(IVET)                                             EVT  550
      NEXTEV = HOTDOG*1.0D-8                                            EVT  560
      TIME = .00100*ITIM                                                EVT  570
      IVEN = NEXTEV*100000000                                           EVT  580
      IUNIT = IVET-IVEN                                                 EVT  590
      ITEMS = ITEMS+1                                                   EVT  600
      IF (X(60).EQ.0.) GO TO 70                                         EVT  610
      WRITE (6,240) TIME,NEXTEV,IUNIT,ITEMS                             EVT  620
C                                                                       EVT  630
   70 DO 80 I=2,LOVER                                                   EVT  640
      IVENTS((I-1),1) = IVENTS(I,1)                                     EVT  650
      IVENTS((I-1),2) = IVENTS(I,2)                                     EVT  660
   80 CONTINUE                                                          EVT  670
C                                                                       EVT  680
      IVENTS(I,1) = 0                                                   EVT  690
      LOVER = LOVER-1                                                   EVT  700
      IF (X(55).EQ.0.) GO TO 90                                         EVT  710
      CALL GETIMX (IET)                                                 EVT  720
      TIMES = IET*.000026                                               EVT  730
      WRITE (6,250) TIMES                                               EVT  740
   90 RETURN                                                            EVT  750
C                                                                       EVT  760
      ENTRY STOREV(T,ID,NUMBER)                                         EVT  770
C                                                                       EVT  780
C             THIS SUBROUTINE ENTRY STORES THE INDICATED EVENT IN       EVT  790
C             ITS PROPER PLACE IN THE EVENTS STORE LIST.  INPUTS ARE    EVT  800
C                                                                       EVT  810
C               T..........THE TIME OF THE EVENT                        EVT  820
C               ID.........THE TYPE OF EVENT                            EVT  830
C               NUMBER.....THE CODE FOR THE UNITS INVOLVED              EVT  840
C                                                                       EVT  850
C             THE PROGRAM STORES THE EVENT BY TIME. IN CASE OF TIES     EVT  860
C             IT SORTS BY LOWEST EVENT TYPE. IF THERE IS STILL A DUPLI- EVT  870
C            CATION IT RESORTS TO THE LARGEST "NUMBER".                 EVT  880
C                                                                       EVT  890
      IQ = X(55)                                                        EVT  900
      IF (IQ.EQ.0) GO TO 100                                            EVT  910
      CALL GETIMX (IET)                                                 EVT  920
      TIMES = IET*.000026                                               EVT  930
      WRITE (6,260) TIMES                                               EVT  940
  100 IF (X(82).LT.T) GO TO 190                                         EVT  950
      IF (LOVER.GE.1000) GO TO 160                                      EVT  960
      ICODE = ID*100000000                                              EVT  970
```

```
      ICODE = ICODE+NUMBER                                              EVT  980
      IT = 1000*(T+.0005)                                               EVT  990
C                                                                       EVT 1000
      DO 110 I=1,1000                                                   EVT 1010
      ITB = IVENTS(I,2)                                                 EVT 1020
      IF (ITB.EQ.0) GO TO 130                                           EVT 1030
      ITM = IVENTS(I,1)                                                 EVT 1040
      IF (IT.LT.ITM) GO TO 130                                          EVT 1050
      IF (IT.EQ.ITM) GO TO 120                                          EVT 1060
  110 CONTINUE                                                          EVT 1070
C                                                                       EVT 1080
      WRITE (6,200)                                                     EVT 1090
      STOP                                                              EVT 1100
  120 IF (ITB.LT.ICODE) GO TO 110                                       EVT 1110
  130 LOVER = LOVER+1                                                   EVT 1120
      IF (X(60).EQ.0.) GO TO 140                                        EVT 1130
      WRITE (6,270) IT,ICODE,LOVER                                      EVT 1140
C                                                                       EVT 1150
  140 DO 150 M=I,LOVER                                                  EVT 1160
      MORE1 = IVENTS(M,1)                                               EVT 1170
      MORE2 = IVENTS(M,2)                                               EVT 1180
      IVENTS(M,1) = IT                                                  EVT 1190
      IVENTS(M,2) = ICODE                                               EVT 1200
      IT = MORE1                                                        EVT 1210
      ICODE = MORE2                                                     EVT 1220
  150 CONTINUE                                                          EVT 1230
C                                                                       EVT 1240
      GO TO 170                                                         EVT 1250
  160 WRITE (6,280) T,ID,NUMBER                                         EVT 1260
  170 IF (IQ.EQ.0) GO TO 180                                            EVT 1270
      CALL GETIMX (IET)                                                 EVT 1280
      TIMES = IET*.000026                                               EVT 1290
      WRITE (6,290) TIMES                                               EVT 1300
  180 RETURN                                                            EVT 1310
  190 IF (X(60).EQ.1.) WRITE (6,300) T,ID,NUMBER                        EVT 1320
      GO TO 170                                                         EVT 1330
C                                                                       EVT 1340
  200 FORMAT ('     EVENTS LIST ITEREATED THROUGH   ERROR')             EVT 1350
  210 FORMAT ('     EVENT IN AT',F15.8)                                 EVT 1360
  220 FORMAT ('      EVENT OUT AT',F15.8)                               EVT 1370
  230 FORMAT ('      GETEV IN AT',F15.8)                                EVT 1380
  240 FORMAT ('0','   THE DATA RETREVED WAS,  TIME',F7.3,'  EVENT TYPE',EVT 1390
     1I2,'  IUNIT',I12,'.'/('          THIS WAS THE',I6,'TH RETREVAL.'))EVT 1400
  250 FORMAT ('       GETEV OUT AT ',F15.8)                             EVT 1410
  260 FORMAT ('0','  STOREV IN AT',F15.8)                               EVT 1420
  270 FORMAT ('0',' EVENT STORED   TIME ',I8,' , CODE IS',I10,',  THERE  EVT 1430
     1ARE NOW',I5,' EVENTS LISTED')                                     EVT 1440
  280 FORMAT ('0','  EVENT LOST--TIME',F9.3,' TYPE',I2,'  CODE',I9,'. OVEVT 1450
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     1ER 1000 EVENTS LISTED.')                                          EVT 1460
 290 FORMAT ('0','  STOREV OUT AT',F15.8)                               EVT 1470
 300 FORMAT ('0','      EVENT LOST DUE TO TIME CONSTRAINT. TIME OF LOST EVT 1480
     1EVENT WAS',F15.4,'  TYPE',I2,', CODE',I10)                        EVT 1490


      SUBROUTINE REMOVE (IUNYT)                                         RMV   10
C                                                                       RMV   20
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMRMV   30
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEERMV   40
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASORMV   50
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QRMV   60
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),RMV   70
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4RMV   80
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             RMV   90
C                                                                       RMV  100
C         THIS ENTRY REMOVES THE TARGET FROM THE EVENTS LIST THAT       RMV  110
C         PRIOR HAS DETERMINED IS MORE THREATENING THAT THE ONE         RMV  120
C         GIVEN IT BY SUBE3                                             RMV  130
C                                                                       RMV  140
      IQ = X(55)                                                        RMV  150
      IF (IQ.EQ.0) GO TO 20                                             RMV  160
      CALL GETIMX (IET)                                                 RMV  170
      TIM = IET*2.6E-5                                                  RMV  180
      WRITE (6,70) TIM                                                  RMV  190
C                                                                       RMV  200
   20 DO 30 I=1,LOVER                                                   RMV  210
      IF (IVENTS(I,2).EQ.IUNYT) GO TO 40                                RMV  220
   30 CONTINUE                                                          RMV  230
C                                                                       RMV  240
      WRITE (6,80) IUNYT                                                RMV  250
      WRITE (6,90) ((IVENTS(I,J),J=1,2),I=1,LOVER)                      RMV  260
      STOP                                                              RMV  270
C                                                                       RMV  280
   40 DO 50 J=I,LOVER                                                   RMV  290
      IVENTS(J,1) = IVENTS((J+1),1)                                     RMV  300
      IVENTS(J,2) = IVENTS((J+1),2)                                     RMV  310
   50 CONTINUE                                                          RMV  320
C                                                                       RMV  330
      LOVER = LOVER-1                                                   RMV  340
      IF (IQ.EQ.0) GO TO 60                                             RMV  350
      CALL GETIMX (IET)                                                 RMV  360
      TIM = IET*2.6E-5                                                  RMV  370
      WRITE (6,100) TIM                                                 RMV  380
   60 RETURN                                                            RMV  390
C                                                                       RMV  400
   70 FORMAT (' REMOVE IN AT',F15.8)                                    RMV  410
   80 FORMAT ('0','ERROR IN REMOVE  IUNYT NOT FOUND'/(' IUNYT WAS',I10/(RMV  420
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     1' EVENTS LIST IS'/)))                                             RMV   430
   90 FORMAT (2I14)                                                     RMV   440
  100 FORMAT (' REMOVE OUT AT',F15.8)                                   RMV   450

      SUBROUTINE TARGET (TYME,IUNIT,MORE)                               TGT    10
C                                                                       TGT    20
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMTGT    30
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEETGT    40
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOTGT    50
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QTGT    60
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),TGT    70
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4TGT    80
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             TGT    90
C                                                                       TGT   100
C        THIS ENTRY CHECKS THE EVENTS LIST TO SEE IF THERE IS A         TGT   110
C        CANDIDATE FOR EVALUATION BY PRIOR                              TGT   120
C                                                                       TGT   130
      IQ = X(55)                                                        TGT   140
      IF (IQ.EQ.0) GO TO 20                                             TGT   150
      CALL GETIMX (IET)                                                 TGT   160
      T = IET*2.6E-5                                                    TGT   170
      WRITE (6,70) T                                                    TGT   180
   20 IT = 1000*(TYME+5.0E-4)                                           TGT   190
      IF (IFIRST.NE.0) GO TO 30                                         TGT   200
      IFIRST = 1                                                        TGT   210
      MORE = 1                                                          TGT   220
      NPGS = 1                                                          TGT   230
   30 IF (IVENTS(NPGS,1).NE.IT) GO TO 60                                TGT   240
      IF (IVENTS(NPGS,2).LT.300000000.OR.IVENTS(NPGS,2).GE.400000000) GOTGT   250
     1 TO 60                                                            TGT   260
      IUNIT = IVENTS(NPGS,2)                                            TGT   270
      NPGS = NPGS+1                                                     TGT   280
   40 IF (IQ.EQ.0) GO TO 50                                             TGT   290
      CALL GETIMX (IET)                                                 TGT   300
      T = IET*2.6E-5                                                    TGT   310
      WRITE (6,80) T                                                    TGT   320
   50 RETURN                                                            TGT   330
   60 IFIRST = 0                                                        TGT   340
      MORE = 0                                                          TGT   350
      GO TO 40                                                          TGT   360
C                                                                       TGT   370
   70 FORMAT (' TARGET IN AT',F15.8)                                    TGT   380
   80 FORMAT (' TARGET OUT AT',F15.8)                                   TGT   390
      END                                                               TGT   400

      SUBROUTINE SUBE1 (TIME,IR)                                        SU1    10
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C                                                                       SU1   20
C        THIS SUBROUTINE INPUTS THE RAIDER NJMBER AND TIME OF THE EVENT,SU1   30
C        AND WILL STORE SHOOT EVENTS IN THE EVENTS LIST AS APPROPRIATE. SU1   40
C                                                                       SU1   50
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMSU1   60
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEESU1   70
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOSU1   80
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QSU1   90
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),SU1  100
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4SU1  110
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             SU1  120
      NASA = 0                                                          SU1  130
      NSURF = 0                                                         SU1  140
      NJ = IFIX(X(17)+AMF)                                              SU1  150
      IF (X(55).EQ.0.) GO TO 20                                         SU1  160
      CALL GETIMX (IET)                                                 SU1  170
      TIM = IET*.000026                                                 SU1  180
      WRITE (6,910) TIM                                                 SU1  190
   20 IF (X(16).EQ.0.) GO TO 30                                         SU1  200
      IF (NASM.GT.0) GO TO 30                                           SU1  210
      TIME = TIME+2.                                                    SU1  220
      CALL STOREV (TIME,1,IR)                                           SU1  230
      GO TO 740                                                         SU1  240
C                                                                       SU1  250
C        CHECK AIR TARGET OR SURFACE TARGET                             SU1  260
C                                                                       SU1  270
   30 ID = 2201+(IR-1)*6                                                SU1  280
      IF (X(ID+3).GT.50.) NASA=1                                        SU1  290
      NOTE = IFIX(X(ID)+AMF)                                            SU1  300
      NIP = (NOTE-1)*20                                                 SU1  310
C                                                                       SU1  320
C        GET RAIDER PARAMETERS                                          SU1  330
C                                                                       SU1  340
      AREA = X(1816+NIP)                                                SU1  350
      SIGMA = X(1815+NIP)                                               SU1  360
      ALT = X(ID+3)                                                     SU1  370
      VEL = X(1814+NIP)                                                 SU1  380
      SALT = X(81)*SQRT(ALT)                                            SU1  390
      IFLAG = 0                                                         SU1  400
      KFLAG = 0                                                         SU1  410
C                                                                       SU1  420
      DO 730 I=1,NS                                                     SU1  430
      IF (SHIP(I,6).GT.0.) GO TO 40                                     SU1  440
      NONO(IR,I) = 7                                                    SU1  450
      GO TO 730                                                         SU1  460
C                                                                       SU1  470
C        CHECK  SHIP FOR TYPE MISSILES                                  SU1  480
C                                                                       SU1  490
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   40 ISI = IFIX(SHIP(I,5)+AMF)                                        SU1   500
      RGE = 0.                                                         SU1   510
      IF (NASA.EQ.1) GO TO 90                                          SU1   520
C                                                                      SU1   530
      DO 70 N=1,4                                                      SU1   540
      IA = IFIX(X(ISI+N-1)+AMF)                                        SU1   550
      IF (IA.EQ.0) GO TO 80                                            SU1   560
      IF (X(536+(IA-1)*40).EQ.0.) GO TO 70                             SU1   570
      IF (NADAR(I,(15+N)).EQ.0) GO TO 70                               SU1   580
      MP = 3+(N-1)*3                                                   SU1   590
C                                                                      SU1   600
      DO 50 K=1,3                                                      SU1   610
      MPI = MP+K                                                       SU1   620
      IF (NADAR(I,MPI).GT.0) GO TO 60                                  SU1   630
   50 CONTINUE                                                         SU1   640
C                                                                      SU1   650
      GO TO 70                                                         SU1   660
   60 ICS = 501+(IA-1)*40                                              SU1   670
      SRAG = X(ICS)                                                    SU1   680
      IF (SRAG.LE.RGE) GO TO 70                                        SU1   690
      RGE = SRAG                                                       SU1   700
      L2 = N                                                           SU1   710
      SAMVEL = X(ICS+1)                                                SU1   720
      NSURF = 1                                                        SU1   730
   70 CONTINUE                                                         SU1   740
C                                                                      SU1   750
   80 IF (NSURF.EQ.1) GO TO 150                                        SU1   760
      NCNO(IR,I) = 9                                                   SU1   770
      IF (X(57).EQ.1.) WRITE (6,920) IR,I                              SU1   780
      GO TO 730                                                        SU1   790
C                                                                      SU1   800
   90 DO 140 L=1,4                                                     SU1   810
      IC = IFIX(X(ISI+L-1)+AMF)                                        SU1   820
      IF (X(536+(IC-1)*40).EQ.1.) GO TO 140                            SU1   830
      IF (NADAR(I,(15+L)).EQ.0) GO TO 140                              SU1   840
      MP = 3+(L-1)*3                                                   SU1   850
C                                                                      SU1   860
      DO 100 K=1,3                                                     SU1   870
      MPI = MP+K                                                       SU1   880
      IF (NADAR(I,MPI).GT.0) GO TO 110                                 SU1   890
  100 CONTINUE                                                         SU1   900
C                                                                      SU1   910
      GO TO 140                                                        SU1   920
  110 IF (ALT.GT.X(77)) GO TO 120                                      SU1   930
      ICS = 503+(IC-1)*40                                              SU1   940
      GO TO 130                                                        SU1   950
  120 ICS = 501+(IC-1)*40                                              SU1   960
  130 SRAG = X(ICS)                                                    SU1   970
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      IF (SRAG.LE.RGE) GO TO 140
      RGE = SRAG
      L2 = L
      SAMVEL = X(ICS+1)
  140 CONTINUE
C
  150 IF (TIME.EQ.0.) GO TO 160
      CALL LOCTIM (IR,TIME,5,XCP,YCP)
      RAID(IR,14) = RAID(IR,5)
      RAID(IR,15) = RAID(IR,6)
C
C        CHECK TO SEE IF TARGET WILL COME WITHIN MAX MISSILE RANGE
C
  160 CALL TMDASM (IR,0,L2,I,VEL,RGE,TIME,TD,XI,YI,RIP,TIML,IR)
      IF (TD.LT.9120.) GO TO 170
      NONO(IR,I) = 9
      GO TO 730
  170 IF (TD.LT.X(82)) GO TO 180
      NONO(IR,I) = 8
      GO TO 730
  180 TFIR = TIML-RGE/SAMVEL
      IF (TFIR.GT.TD) GO TO 190
      NONO(IR,I) = 8
      GO TO 730
  190 KFLAG = 0
      TA = 0.
      TRGE = 1000.
      RGTI = 0.
      RGE = 0.
      JACK(I,1) = JACK(I,1)+1
      JACK(I,4) = JACK(I,4)+1
      NFOG = 0
      MFOG = 0
      JFOG = 0
      CALL CPA (RAID(IR,3),RAID(IR,4),RAID(IR,14),RAID(IR,15),SHIP(I,2),
     1SHIP(I,3),XCP,YCP)
      RCPS = (SHIP(I,2)-XCP)**2+(SHIP(I,3)-YCP)**2+(RAID(IR,9)/6000.)**2
C
C        CHECK SEARCH RADARS    SEE IF ONE IS OPERABLE
C
      DO 280 NSR=1,3
      IF (NADAR(I,NSR).EQ.0) GO TO 280
      KFLAG = 1
      ID = IFIX(X(ISI+3+NSR)+AMF)
      IA = IFIX(X(901+(ID-1)*20)+AMF)
C
C        BI-STATIC/MONO-STATIC FLAG
C
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      IF (IA.EQ.0) GO TO 790                                            SU1 1460
C                                                                       SU1 1470
C        MONOSTATIC DETECTION ALGORITHM                                 SU1 1480
C                                                                       SU1 1490
      SRAG = X(902+(ID-1)*20)*AREA                                      SU1 1500
      RRH = X(81)*SQRT(X(ISI+6+NSR))                                    SU1 1510
      HRAG = RRH+SALT                                                   SU1 1520
      THR = X(905+(ID-1)*20)                                            SU1 1530
      RG = AMIN1(SRAG,HRAG,THR)                                         SU1 1540
      IF (NJ.EQ.0) GO TO 200                                            SU1 1550
      IJ = IFIX(X(907+(ID-1)*20)+AMF)                                   SU1 1560
      IF (JAM(IJ).EQ.0) GO TO 200                                       SU1 1570
      CALL JAMM (RG,I,IR,IJ,ID,VEL,RRH,AREA,0,ICPA,RGI)                 SU1 1580
      IF (ICPA.EQ.0) GO TO 280                                          SU1 1590
      RAGJ = RGI                                                        SU1 1600
      GO TO 210                                                         SU1 1610
  200 IF (RCPS.GE.RG**2) GO TO 280                                      SU1 1620
      RGI = RG                                                          SU1 1630
      RAGJ = 999.                                                       SU1 1640
  210 IF (X(3).EQ.0.) GO TO 220                                         SU1 1650
      WRITE (6,930) I,IR,NSR                                            SU1 1660
      WRITE (6,940) SRAG,RAGJ,HRAG                                      SU1 1670
  220 CALL TMDASM (IR,0,NSR,I,VEL,RGI,TIME,TI,XI,YI,RIP,TIML,IR)        SU1 1680
  230 IF (TA.LT.TIML) TA = TIML                                         SU1 1690
C                                                                       SU1 1700
C        PUT IN DETECTION REACTION TIME                                 SU1 1710
C                                                                       SU1 1720
      IF (X(10).EQ.0.) GO TO 250                                        SU1 1730
      IF (VEL.LT.1.0E-5) GO TO 240                                      SU1 1740
      RGE = ABS(RIP-DELR*VEL)                                           SU1 1750
      GO TO 260                                                         SU1 1760
  240 DELR = X(87)                                                      SU1 1770
      GO TO 260                                                         SU1 1780
  250 KEY = IFIX(X(906+(ID-1)*20)+AMF)                                  SU1 1790
      CALL REACT (1,KEY,DELR)                                           SU1 1800
  260 TDET = TI+DELR                                                    SU1 1810
C                                                                       SU1 1820
C        CHECK FOR MAXIMUM RANGE                                        SU1 1830
C                                                                       SU1 1840
      IF (TRGE.LE.TDET) GO TO 270                                       SU1 1850
      RGE = RIP-DELR*VEL                                                SU1 1860
      TRGE = TDET                                                       SU1 1870
  270 IF (NFOG.GT.0) GO TO 830                                          SU1 1880
  280 CONTINUE                                                          SU1 1890
C                                                                       SU1 1900
C        IF KFLAG IS 0 NO SEARCH RADARS ARE UP   GO CHECK               SU1 1910
C        DIRECTORS FOR HORIZON SEARCH MODE                              SU1 1920
C                                                                       SU1 1930
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      IF (KFLAG.EQ.0) GO TO 610
      IF (TRGE.LT.TA) GO TO 290
      IF (MFOG.GT.0) GO TO 830
      NONO(IR,I) = 2
      GO TO 730
  290 RGFC = 0.
C
C        INCRIMENT THE ENGAGEMENTS POSSIBLE AND RAIDERS ENGAGABLE
C        COUNTERS, THEN CHECK TO SEE IF DETECTION OCCURED.. IF
C        IT DID, SET THE TARGET PROCESSING DELAYS.
C
      JACK(I,5) = JACK(I,5)+1
      STATS(I,1) = STATS(I,1)+RGE
C
C        DETERMINATION OF FC RADAR  ACQUISITION RANGE.
C
      DO 380 NB=1,4
      MTY = IFIX(X(ISI-1+NB)+AMF)
      IF (MTY.EQ.0) GO TO 390
      MTQ = NB+15
      IF (NADAR(I,MTQ).EQ.0) GO TO 380
C
      DO 370 NF=1,3
      MTZ = (MTY-1)*40
      NPQ = 3+(NB-1)*3+NF
      NAD = NADAR(I,NPQ)+1
      GO TO (370,300,340), NAD
  300 IA = IFIX(X(516+NF*2+MTZ*40)+AMF)
      SRFC = X(902+(IA-1)*20)*AREA
      FCRH = X(81)*SQRT(X(ISI+9+NB))
      HRFC = FCRH+SALT
      THR = X(905+(IA-1)*20)
      FRG = AMIN1(SRFC,HRFC,THR)
      IF (NJ.EQ.0) GO TO 310
      IJ = IFIX(X(907+(IA-1)*20)+AMF)
      IF (JAM(IJ).EQ.0) GO TO 310
      CALL JAMM (FRG,I,IR,IJ,IA,VEL,FCRH,AREA,0,JCPA,RGF)
      IF (JCPA.EQ.0) GO TO 370
      RFCJ = RGF
      GO TO 320
  310 IF (RCPS.GE.FRG**2) GO TO 370
      RGF = FRG
      RFCJ = 999.
  320 IF (X(57).EQ.0.) GO TO 330
      WRITE (6,950) I,IR,NB,NF
      WRITE (6,940) SRFC,RFCJ,HRFC
  330 IF (RGFC.GE.RGF) GO TO 370
      RGFC = RGF
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      IFC = NB                                                          SU1 2420
      IFA = NF                                                          SU1 2430
      GO TO 370                                                         SU1 2440
  340 IF (ALT.GT.X(77)) GO TO 350                                       SU1 2450
      RGM = X(508+MTZ)                                                  SU1 2460
      SVEL = X(509+MTZ)                                                 SU1 2470
      GO TO 360                                                         SU1 2480
  350 RGM = X(501+MTZ)                                                  SU1 2490
      SVEL = X(502+MTZ)                                                 SU1 2500
  360 RGF = RGM*(1+VEL/SVEL)                                            SU1 2510
      IF (RGFC.GE.RGF) GO TO 380                                        SU1 2520
      IFC = NB                                                          SU1 2530
      IFA = 0                                                           SU1 2540
      RGFC = RGF                                                        SU1 2550
      GO TO 380                                                         SU1 2560
  370 CONTINUE                                                          SU1 2570
C                                                                       SU1 2580
  380 CONTINUE                                                          SU1 2590
C                                                                       SU1 2600
C          CHECK TO SEE IF TARGET WILL COME WITHIN THE MAX              SU1 2610
C          FC RADAR ACQUISITION RANGE.                                  SU1 2620
C                                                                       SU1 2630
  390 CALL TMDASM (IR,0,IFC,I,VEL,RGFC,TIME,TFR,XI,YI,RIP,TIML,IR)      SU1 2640
      IF (X(3).EQ.0.) GO TO 410                                         SU1 2650
      IF (JFOG.EQ.1) GO TO 400                                          SU1 2660
      WRITE (6,960) IR,I,TRGE,TFR                                       SU1 2670
      GO TO 410                                                         SU1 2680
  400 WRITE (6,970) IR,I,TRGE,TFR                                       SU1 2690
  410 PROB = X(ISI+15)                                                  SU1 2700
      CALL RANDOM (ISEED,Z,1)                                           SU1 2710
      X(13) = X(13)+1.                                                  SU1 2720
      IF (PROB.GT.Z) GO TO 420                                          SU1 2730
      NONO(IR,I) = 3                                                    SU1 2740
      GO TO 730                                                         SU1 2750
  420 IF (TA.LT.TFR) GO TO 810                                          SU1 2760
      KEY = IFIX(X(ISI+16)+AMF)                                         SU1 2770
      CALL REACT (2,KEY,TWDS)                                           SU1 2780
      KEY = IFIX(X(ISI+17)+AMF)                                         SU1 2790
      CALL REACT (3,KEY,TDES)                                           SU1 2800
      MTY = IFIX(X(ISI-1+IFC)+AMF)                                      SU1 2810
      MTZ = (MTY-1)*40                                                  SU1 2820
      IF (IFA.EQ.0) GO TO 430                                           SU1 2830
      IA = IFIX(X(516+IFA*2+MTZ)+AMF)                                   SU1 2840
      KEY = IFIX(X(906+(IA-1)*20)+AMF)                                  SU1 2850
      CALL REACT (4,KEY,TAC)                                            SU1 2860
      TSR = TRGE+TWDS+TDES+TAC                                          SU1 2870
      GO TO 440                                                         SU1 2880
  430 TSR = TRGE+TWDS+TDES                                              SU1 2890
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  440 IF (ALT.GT.X(77)) GO TO 450                                        SU1 2900
      SVEL = X(508+MTZ)                                                  SU1 2910
      GO TO 460                                                          SU1 2920
  450 SVEL = X(502+MTZ)                                                  SU1 2930
  460 TLS = TIML-RGFC/SVEL                                               SU1 2940
C                                                                        SU1 2950
C        COMPARE LAST TIME TO FIRE TO FINAL DETECT PLUS PROCESS TIME.    SU1 2960
C                                                                        SU1 2970
      IF (TSR.LT.TLS) GO TO 470                                          SU1 2980
      IF (MFOG.GT.0) GO TO 830                                           SU1 2990
      NONO(IR,I) = 5                                                     SU1 3000
      GO TO 730                                                          SU1 3010
C                                                                        SU1 3020
C        GET LAUNCH TIME AND COMPARE WITH LAST TIME TO FIRE.             SU1 3030
C                                                                        SU1 3040
  470 KEY = IFIX(X(ISI+18)+AMF)                                          SU1 3050
      CALL REACT (5,KEY,TFIRE)                                           SU1 3060
      IF (TRGE.GT.TFR) GO TO 480                                         SU1 3070
      TSHOOT = TFR+TFIRE                                                 SU1 3080
      GO TO 490                                                          SU1 3090
  480 TSHOOT = TSR+TFIRE                                                 SU1 3100
  490 IF (X(3).EQ.0.) GO TO 500                                          SU1 3110
      WRITE (6,980) IR,I,TSHOOT,DELR,TWDS                                SU1 3120
      WRITE (6,990) TDES,TFIRE                                           SU1 3130
  500 IF (TSHOOT.LT.TLS) GO TO 510                                       SU1 3140
      IF (MFOG.GT.0) GO TO 830                                           SU1 3150
      NONO(IR,I) = 5                                                     SU1 3160
      GO TO 730                                                          SU1 3170
  510 IF (NASA.EQ.0) GO TO 560                                           SU1 3180
C                                                                        SU1 3190
C        ENTER A SHOOT EVENT FOR EACH OPERATIONAL DIRECTOR LAUNCHER      SU1 3200
C        COMBINATION IN THIS BATTERY.                                    SU1 3210
C                                                                        SU1 3220
C        IF THE MISSILE FLYS INDEPENDENTLY OF THE DIRECTOR THROUGHOUT    SU1 3230
C        ITS FLIGHT, ASSIGN THE NUMBER 7 TO THE CHANNEL SLOT.            SU1 3240
C                                                                        SU1 3250
      DO 540 MS=1,4                                                      SU1 3260
      MJL = 15+MS                                                        SU1 3270
      IF (NADAR(I,MJL).EQ.0) GO TO 540                                   SU1 3280
      ID = IFIX(X(ISI+MS-1)+AMF)                                         SU1 3290
      IF (X(536+(ID-1)*40).EQ.1.) GO TO 540                              SU1 3300
      MP = 3+(MS-1)*3                                                    SU1 3310
C                                                                        SU1 3320
      DO 530 MT=1,3                                                      SU1 3330
      MPI = MP+MT                                                        SU1 3340
      LARRY = NADAR(I,MPI)+1                                             SU1 3350
      GO TO (530,520,550,530), LARRY                                     SU1 3360
  520 KS = I*1000+MS*100+MT*10+IR*100000                                 SU1 3370
```

```
      CALL STOREV (TSHOOT,3,KS)                                         SU1 3380
  530 CONTINUE                                                          SU1 3390
C                                                                       SU1 3400
  540 CONTINUE                                                          SU1 3410
C                                                                       SU1 3420
      GO TO 730                                                         SU1 3430
  550 KS = I*1000+MS*100+MT*10+IR*100000+7                              SU1 3440
      CALL STOREV (TSHOOT,3,KS)                                         SU1 3450
      GO TO 540                                                         SU1 3460
C                                                                       SU1 3470
  560 DO 590 MS=1,4                                                     SU1 3480
      MJL = 15+MS                                                       SU1 3490
      IF (NADAR(I,MJL).EQ.0) GO TO 590                                  SU1 3500
      ID = IFIX(X(ISI+MS-1)+AMF)                                        SU1 3510
      IF (X(536+(ID-1)*40).EQ.0.) GO TO 590                             SU1 3520
      MP = 3+(MS-1)*3                                                   SU1 3530
C                                                                       SU1 3540
      DO 580 MT=1,3                                                     SU1 3550
      MPI = MP+MT                                                       SU1 3560
      LOIS = NADAR(I,MPI)+1                                             SU1 3570
      GO TO (580,570,600,580), LOIS                                     SU1 3580
  570 KS = I*1000+MS*100+MT*10+IR*100000                                SU1 3590
      CALL STOREV (TSHOOT,3,KS)                                         SU1 3600
  580 CONTINUE                                                          SU1 3610
C                                                                       SU1 3620
  590 CONTINUE                                                          SU1 3630
C                                                                       SU1 3640
      GO TO 730                                                         SU1 3650
  600 KS = I*1000+MS*100+MT*10+IR*100000+7                              SU1 3660
      CALL STOREV (TSHOOT,3,KS)                                         SU1 3670
      GO TO 590                                                         SU1 3680
C                                                                       SU1 3690
C        THE HORIZON SEARCH DETECTION ALGORITHM                         SU1 3700
C                                                                       SU1 3710
  610 RGFC = 0.                                                         SU1 3720
C                                                                       SU1 3730
      DO 660 NB=1,4                                                     SU1 3740
      IFCR = IFIX(X(ISI-1+NB)+AMF)                                      SU1 3750
      IF (IFCR.EQ.0) GO TO 660                                          SU1 3760
      ICH = (NB-1)*3+3                                                  SU1 3770
C                                                                       SU1 3780
      DO 650 NF=1,3                                                     SU1 3790
      NFG = ICH+NF                                                      SU1 3800
      IF (NADAR(K,NFG).NE.3) GO TO 650                                  SU1 3810
      HT = X(ISI+10+NF)                                                 SU1 3820
      HFCSR = X(81)*SQRT(HT)                                            SU1 3830
      HORZ = HFCSR+SALT                                                 SU1 3840
      ICL = IFIX(X(516+(IFCR-1)*40+2*NF)+AMF)                           SU1 3850
```

```
      RRFC = X(902+(ICL-1)*20)*AREA                                     SU1 3860
      THR = X(905+(ICL-1)*20)                                           SU1 3870
      HSFR = AMIN1(RRFC,HORZ,THR)                                       SU1 3880
      IF (NJ.EQ.0) GO TO 620                                            SU1 3890
      IJ = IFIX(X(907+(ICL-1)*20)+AMF)                                  SU1 3900
      IF (JAM(IJ).EQ.0) GO TO 620                                       SU1 3910
      CALL JAMM (HSFR,I,IR,IJ,ICL,VEL,HFCSR,AREA,0,LCPA,RGF)            SU1 3920
      IF (LCPA.EQ.0) GO TO 650                                          SU1 3930
      RFCJ = RGF                                                        SU1 3940
      GO TO 630                                                         SU1 3950
  620 IF (RCPS.GE.HSFR**2) GO TO 650                                    SU1 3960
      RGF = HSFR                                                        SU1 3970
      RFCJ = 999.                                                       SU1 3980
  630 IF (X(57).EQ.0.) GO TO 640                                        SU1 3990
      WRITE (6,1000) I,IR                                               SU1 4000
      WRITE (6,940) RRFC,RFCJ,HORZ                                      SU1 4010
  640 IF (RGF.LT.RGFC) GO TO 650                                        SU1 4020
      RGFC = RGF                                                        SU1 4030
      IFC = NB                                                          SU1 4040
      IFA = NF                                                          SU1 4050
  650 CONTINUE                                                          SU1 4060
C                                                                       SU1 4070
  660 CONTINUE                                                          SU1 4080
C                                                                       SU1 4090
C        THE HORIZON SEARCH DELAY TO FIRE REACTION TIMES ASSESSMENT     SU1 4100
C                                                                       SU1 4110
      JACK(I,5) = JACK(I,5)+1                                           SU1 4120
      MTY = IFIX(X(ISI-1+IFC)+AMF)                                      SU1 4130
      MTZ = (MTY-1)*40                                                  SU1 4140
      KEY = IFIX(X(516+(IA-1)*20)+AMF)                                  SU1 4150
      CALL REACT (6,KEY,TAC)                                            SU1 4160
      KEY = IFIX(X(ISI+18)+AMF)                                         SU1 4170
      CALL REACT (5,KEY,TFIRE)                                          SU1 4180
      KEY = IFIX(X(ISI+19)+AMF)                                         SU1 4190
      CALL REACT (7,KEY,THSCAN)                                         SU1 4200
      CALL TMDASM (IR,0,IFC,I,VEL,RGFC,TIME,TD,XI,YI,RIP,TIML,IR)       SU1 4210
      TSHOOT = TD+TAC+AMAX1(TFIRE,THSCAN)                               SU1 4220
      IF (TSHOOT.GT.X(82)) GO TO 670                                    SU1 4230
      STATS(I,1) = STATS(I,1)+RIP                                       SU1 4240
      IF (NASA.EQ.0) GO TO 680                                          SU1 4250
      IF (ALT.GT.X(77)) GO TO 680                                       SU1 4260
      SVEL = X(508+MTZ)                                                 SU1 4270
      GO TO 690                                                         SU1 4280
  670 NONO(IR,I) = 4                                                    SU1 4290
      GO TO 730                                                         SU1 4300
  680 SVEL = X(502+MTZ)                                                 SU1 4310
  690 TLS = TIML-RGFC/SVEL                                              SU1 4320
      IF (TSHOOT.LE.TLS) GO TO 700                                      SU1 4330
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      NCNO(IR,I) = 5                                                    SU1 4340
      GO TO 730                                                         SU1 4350
  700 IF (NASA.EQ.0) GO TO 760                                          SU1 4360
C                                                                       SU1 4370
      DO 720 MS=1,4                                                     SU1 4380
      IPQ = 15+MS                                                       SU1 4390
      IF (NADAR(I,IPQ).EQ.0) GO TO 720                                  SU1 4400
      ID = IFIX(X(ISI-1+MS)+AMF)                                        SU1 4410
      IF (X(536+(ID-1)*40).EQ.1.) GO TO 720                             SU1 4420
      MP = 3+(MS-1)*3                                                   SU1 4430
C                                                                       SU1 4440
      DO 710 MT=1,3                                                     SU1 4450
      MPI = MP+MT                                                       SU1 4460
      IF (NADAR(I,MPI).NE.3) GO TO 710                                  SU1 4470
      KS = I*1000+MS*100+MT*10+IR*100000                                SU1 4480
      CALL STOREV (TSHOOT,3,KS)                                         SU1 4490
  710 CONTINUE                                                          SU1 4500
C                                                                       SU1 4510
  720 CONTINUE                                                          SU1 4520
C                                                                       SU1 4530
  730 CONTINUE                                                          SU1 4540
C                                                                       SU1 4550
  740 IF (X(55).EQ.0.) GO TO 750                                        SU1 4560
      CALL GETIMX (IET)                                                 SU1 4570
      TIM = IET*.000026                                                 SU1 4580
      WRITE (6,1010) TIM                                                SU1 4590
  750 RETURN                                                            SU1 4600
C                                                                       SU1 4610
C         ONE OF THE SURFACE TO SURFACE  SHOOT ENTRIES.                 SU1 4620
C                                                                       SU1 4630
  760 DO 780 MS=1,4                                                     SU1 4640
      IPQ = 15+MS                                                       SU1 4650
      IF (NADAR(I,IPQ).EQ.0) GO TO 780                                  SU1 4660
      ID = IFIX(X(ISI-1+MS)+AMF)                                        SU1 4670
      IF (X(536+(ID-1)*40).EQ.0.) GO TO 730                             SU1 4680
      MP = 3+(MS-1)*3                                                   SU1 4690
C                                                                       SU1 4700
      DO 770 MT=1,3                                                     SU1 4710
      MPI = MP+MT                                                       SU1 4720
      IF (NADAR(I,MPI).NE.3) GO TO 770                                  SU1 4730
      KS = I*1000+MS*100+MT*10+IR*100000                                SU1 4740
      CALL STOREV (TSHOOT,3,KS)                                         SU1 4750
  770 CONTINUE                                                          SU1 4760
C                                                                       SU1 4770
  780 CONTINUE                                                          SU1 4780
C                                                                       SU1 4790
      GO TO 730                                                         SU1 4800
C                                                                       SU1 4810
```

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C         THE BI-STATIC DETECTION ALGORITHM                                 SU1 4820
C                                                                           SU1 4830
  790 CALL BIDET (I,NSR,ALT,IR,VEL,SIGMA,ND,TI,TIML,RGI,TD2,TIML2,R2,0)     SU1 4840
      IF (TI.LT.TIME) TI = TIME                                             SU1 4850
      IF (ND.EQ.0) GO TO 800                                                SU1 4860
      IF (X(3).EQ.1.) WRITE (6,1020) IR,I,TI,TIML                           SU1 4870
      IF (ND.EQ.1) GO TO 800                                                SU1 4880
      IF (X(3).EQ.1.) WRITE (6,1030) TD2,TIML2                              SU1 4890
  800 ND = ND+1                                                             SU1 4900
      GO TO (820,230,870), ND                                               SU1 4910
  810 NONO(IR,I) = 4                                                        SU1 4920
      GO TO 730                                                             SU1 4930
  820 TI = 9120.                                                            SU1 4940
      TIML = 0.                                                             SU1 4950
      RGI = 0.                                                              SU1 4960
      GO TO 230                                                             SU1 4970
  830 RGE = 0.                                                              SU1 4980
      TRGE = 1000.                                                          SU1 4990
      TA = 0.                                                               SU1 5000
      GO TO (840,850,860), MFOG                                             SU1 5010
  840 TI = TTA                                                              SU1 5020
      TIML = TIMLA                                                          SU1 5030
      RGI = RGIA                                                            SU1 5040
      MFOG = MFOG-1                                                         SU1 5050
      JFOG = 1                                                              SU1 5060
      NFOG = 0                                                              SU1 5070
      GO TO 230                                                             SU1 5080
  850 TI = TTB                                                              SU1 5090
      TIML = TIMLB                                                          SU1 5100
      RGI = RGIB                                                            SU1 5110
      MFOG = MFOG-1                                                         SU1 5120
      GO TO 230                                                             SU1 5130
  860 TI = TTC                                                              SU1 5140
      RGI = RGIC                                                            SU1 5150
      TIML = TIMLC                                                          SU1 5160
      MFOG = MFOG-1                                                         SU1 5170
      GO TO 230                                                             SU1 5180
  870 MFOG = MFOG+1                                                         SU1 5190
      GO TO (880,890,900), MFOG                                             SU1 5200
  880 TTA = TD2                                                             SU1 5210
      TIMLA = TIML2                                                         SU1 5220
      RGIA = R2                                                             SU1 5230
      GO TO 230                                                             SU1 5240
  890 TTB = TD2                                                             SU1 5250
      TIMLB = TIML2                                                         SU1 5260
      NFOG = 1                                                              SU1 5270
      RGIB = R2                                                             SU1 5280
      GO TO 230                                                             SU1 5290
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  900 TTC = TD2                                                         SU1 5300
      TIMLC = TIML2                                                     SU1 5310
      RGIC = R2                                                         SU1 5320
      GO TO 230                                                         SU1 5330
C                                                                       SU1 5340
  910 FORMAT ('    SUBE1 IN AT',F15.8)                                  SU1 5350
  920 FORMAT ('0','    RAIDER',I3,' SURFACE OR SUBMARINE UNIT, SHIP',I3,SU1 5360
     1' HAS NO SSM')                                                    SU1 5370
  930 FORMAT ('0',' DETECTION RANGES OF SHIP',I3,' ON RAIDER',I3,' WITH SU1 5380
     1RADAR',I2)                                                        SU1 5390
  940 FORMAT ('    CLEAR ENVIRONMENT... ',F9.4/('    JAMMING ENVIRONMENT. SU1 5400
     1',F9.4/('    RADAR HORIZON....... ',F9.4)))                       SU1 5410
  950 FORMAT (' AQUISITION RANGES FOR SHIP',I3,' ON RAIDER',I3,' WITH SYSU1 5420
     1STEM',I2,' FC RADAR TYPE',I3)                                     SU1 5430
  960 FORMAT (' INITIAL DETECTION OF RAIDER',I3,' BY SHIP',I3/('    SEARCSU1 5440
     1H RADAR',F9.4,4X,'FC LOCK ON',F9.4))                              SU1 5450
  970 FORMAT ('  SECOND DETECTION (BI-STATIC) ON RAIDER',I3,' BY SHIP',ISU1 5460
     13/('     SEARCH RADAR DECTECTION TIME',F9.4,' LAST TIME TO SHOOT',SU1 5470
     2F9.4))                                                            SU1 5480
  980 FORMAT (' RAIDER',I3,' FIRING SHIP',I3,' TSHOOT WAS',F9.4/('    DETSU1 5490
     1ECTION DELAY WAS',F9.4/('    WDE TRACK DELAY WAS',F9.4)))         SU1 5500
  990 FORMAT ('    DESIGNATION DELAY WAS',F9.4/('    FIRING DELAY WAS',F9.SU1 5510
     14))                                                               SU1 5520
 1000 FORMAT ('    HORIZON SEARCH DETECTION FOR SHIP',I3,' VS. RAIDER',I3SU1 5530
     1)                                                                 SU1 5540
 1010 FORMAT ('    SUBE1 OUT AT',F15.8)                                 SU1 5550
 1020 FORMAT ('0','  FIRST BI-STAT DET ON RAIDER',I3,' BY SHIP',I3,' WASSU1 5560
     1 AT',F9.4,'    DET LOST AT',F9.4)                                 SU1 5570
 1030 FORMAT ('      SECOND DET AT',F9.4,'  LOST DET AT',F9.4)          SU1 5580
      END                                                               SU1 5590


      SUBROUTINE SUBE2 (TIME,IR)                                        SU2   10
C                                                                       SU2   20
C        THIS SUBROUTINE COMPUTES THE LAUNCH TIME FOR ALL RED           SU2   30
C        ASM/SSM AND DETERMINES THE POSSIBLE SAM LAUNCH TIMES FOR       SU2   40
C        BLUE MISSILE LAUNCHERS                                         SU2   50
C                                                                       SU2   60
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMSU2   70
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEESU2   80
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOSU2   90
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QSU2  100
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),SU2  110
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4SU2  120
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             SU2  130
      DIMENSION TTARG(40,2)                                             SU2  140
      KING = 0                                                          SU2  150
      NJ = IFIX(X(17)+AMF)                                              SU2  160
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```
      IFLAG = 0                                                         SU2  170
      KATHY = 0                                                         SU2  180
      JFLAG = 0                                                         SU2  190
      IF (X(55).EQ.0.) GO TO 20                                         SU2  200
      CALL GETIMX (IET)                                                 SU2  210
      T = .000026*IET                                                   SU2  220
      WRITE (6,1100) T                                                  SU2  230
   20 NG = RAID(IR,13)                                                  SU2  240
      IF (NG.EQ.0) GO TO 910                                            SU2  250
C                                                                       SU2  260
C        CHECK TO SEE IF RAIDER IS STILL VIABLE                         SU2  270
C                                                                       SU2  280
C        IF THIS IS THE FIRST ASM TO BE FIRED, SET THE TIMER TMAX.      SU2  290
C                                                                       SU2  300
      IF (IFLASK.GT.0) GO TO 30                                         SU2  310
      TMAX = TIME+X(84)                                                 SU2  320
      IFLASK = 1                                                        SU2  330
   30 ID = 2201+(IR-1)*6                                                SU2  340
      IJ = IFIX(X(ID)+AMF)                                              SU2  350
      ICOP = (IJ-1)*20                                                  SU2  360
      NONE = 1                                                          SU2  370
      VEL = X(1814+ICOP)                                                SU2  380
      IF (X(ID+3).LE.50.) GO TO 1040                                    SU2  390
      IF (TIME.GE.TMAX) GO TO 1080                                      SU2  400
C                                                                       SU2  410
C        DETERMINE THE RAIDERS LAUNCH INTERVAL FOR THIS SERIES OF       SU2  420
C        MISSILE FIRINGS.                                               SU2  430
C                                                                       SU2  440
      TINT = TIME+X(83)                                                 SU2  450
      IFLASK = 2                                                        SU2  460
      IF (TINT.GT.TMAX) TINT=TMAX                                       SU2  470
      W = TINT-TIME                                                     SU2  480
      NTOT = MISLFT(IR,1)+MISLFT(IR,2)                                  SU2  490
C                                                                       SU2  500
C        SURFACE TO SURFACE TARGETING DIVERSION                         SU2  510
C                                                                       SU2  520
      IF (NTOT.EQ.0) GO TO 910                                          SU2  530
C                                                                       SU2  540
C        DETERMINE THE NUMBER AND TYPE OF MISSILES TO BE FIRED          SU2  550
C        FIRST, AND THOSE, IF ANY, TO BE FIRED SECOND.                  SU2  560
C                                                                       SU2  570
      CALL RANDOM (ISEED,QRT,NTOT)                                      SU2  580
      X(13) = X(13)+FLOAT(NTOT)                                         SU2  590
      CALL TJSORT (QRT,NTOT)                                            SU2  600
   40 LNUM = IFIX(RAID(IR,11)+AMF)                                      SU2  610
      J = IFIX(X(1804+ICOP)+AMF)                                        SU2  620
      IF (LNUM.NE.J) GO TO 50                                           SU2  630
      NCW = 1                                                           SU2  640
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      NEXT = 2
      NMIS = MISLFT(IR,1)
      IF (NMIS.EQ.0) GO TO 50
      GO TO 60
   50 J = IFIX(X(1806+ICOP)+AMF)
      NMIS = MISLFT(IR,2)
      NEXT = 1
      NOW = 2
      IF (NMIS.NE.0) GO TO 60
      J = X(1804+ICOP)
      NMIS = MISLFT(IR,1)
      NOW = 1
C
C        GET THE ASM'S CHARACTERISTICS
C
   60 IK = 2001+(J-1)*10
      SIGMA = X(IK+5)
      SPD = X(IK)
      AREA = X(IK+9)
      ALT = X(IK+1)
      SALT = X(IK+8)
      RELI = X(IK+3)
C
      DO 870 I=1,NMIS
      KAT = JFLAG+1
      GO TO (70,1070,1050), KAT
   70 IF (I.GT.1) GO TO 80
      IF (KATHY.GT.0) GO TO 80
      TM = TIME
      GO TO 100
C
C        GET THE PROPOSE LAUNCH TIME
C        CHOOSE A TARGET FOR THE CANDIDATE ASM
C
   80 TX = W*GRT(NONE)
      NONE = NONE+1
   90 TM = TIME+TX
  100 CALL LOCTIM (IR,TM,5,XU,Y)
      IPQ = NRTGT(IR)
      IDP = 0
C
C        DETERMINE WHICH OF THE TARGETS ON THE RAIDERS
C        TARGET LIST CAN BE TARGETED AND FILL IN THE TEMPORARY
C        TARGET LIST.
C
      DO 140 NT=1,NS
      IF (NT.GT.1) GO TO 110
      RT = PLIST(NT,IPQ)
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      GO TO 120                                                         SU2 1130
  110 RT = PLIST(NT,IPQ)-PLIST((NT-1),IPQ)                              SU2 1140
  120 IF (RT.LT.0.0005) GO TO 140                                       SU2 1150
      IF (SHIP(NT,6).GT.0.) GO TO 130                                   SU2 1160
      IF (X(5).EQ.1.) GO TO 130                                         SU2 1170
      MARIE = IFIX(SHIP(NT,4)+AMF)                                      SU2 1180
      IF (IHIT(NT).GE.MARIE) GO TO 140                                  SU2 1190
  130 CALL RCHECK (NT,IR,KQED)                                          SU2 1200
      IF (KQED.EQ.1) GO TO 140                                          SU2 1210
      IDP = IDP+1                                                       SU2 1220
      TTARG(IDP,1) = FLOAT(NT)                                          SU2 1230
      TTARG(IDP,2) = PLIST(NT,IPQ)                                      SU2 1240
  140 CONTINUE                                                          SU2 1250
C                                                                       SU2 1260
  150 IF (IDP.EQ.0) GO TO 180                                           SU2 1270
      CALL RANDOM (ISEED,Z,1)                                           SU2 1280
      X(13) = X(13)+1.                                                  SU2 1290
C                                                                       SU2 1300
      DO 160 NT=1,IDP                                                   SU2 1310
      IF (Z.LE.TTARG(NT,2)) GO TO 170                                   SU2 1320
  160 CONTINUE                                                          SU2 1330
C                                                                       SU2 1340
      NT = IDP                                                          SU2 1350
      IOU = IFIX(TTARG(IDP,1)+AMF)                                      SU2 1360
      GO TO 190                                                         SU2 1370
  170 IOU = IFIX(TTARG(NT,1)+AMF)                                       SU2 1380
      GO TO 190                                                         SU2 1390
  180 CALL STOREV ((TM+3.),2,IR)                                        SU2 1400
      IF (NASM.EQ.0) IFLASK=0                                           SU2 1410
      GO TO 910                                                         SU2 1420
C                                                                       SU2 1430
C        CHECK TO SEE IF THE TARGET CHOSEN IS A DESIGNATED              SU2 1440
C        NON-RADIATING PICKET                                           SU2 1450
C                                                                       SU2 1460
  190 ISI = IFIX(SHIP(IOU,5)+AMF)                                       SU2 1470
      L2 = IFIX(X(ISI+30)+AMF)                                          SU2 1480
      IF (L2.EQ.0) GO TO 250                                            SU2 1490
C                                                                       SU2 1500
C        IF SO DETERMINE IF IT CAN BE TARGETED.   IF IT CAN,            SU2 1510
C        PROCEED, OTHERWISE ELIMINATE IT FROM THE TEMPORARY TARGET      SU2 1520
C        LIST AND TRY AGAIN.                                            SU2 1530
C                                                                       SU2 1540
      CALL RANDOM (ISEED,Z,1)                                           SU2 1550
      X(13) = X(13)+1.                                                  SU2 1560
      IF (RAID(IR,9).GT.X(20)) GO TO 200                                SU2 1570
      IF (Z.LE.X(22)) GO TO 240                                         SU2 1580
      GO TO 210                                                         SU2 1590
  200 IF (Z.LE.X(21)) GO TO 240                                         SU2 1600
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  210 IF (IDP.NE.IOU) GO TO 220                                          SU2 1610
      IDP = IDP-1                                                       SU2 1620
      GO TO 150                                                         SU2 1630
  220 IF (NT.EQ.1) GO TO 230                                            SU2 1640
      L2 = NT-1                                                         SU2 1650
      TTARG(NT,2) = TTARG(L2,2)                                         SU2 1660
      GO TO 150                                                         SU2 1670
  230 TTARG(1,2) = 0.                                                   SU2 1680
      GO TO 150                                                         SU2 1690
  240 TRGE = X(23)**2                                                   SU2 1700
      DELTAX = ABS(SHIP(IOU,2)-RAID(IR,3))                              SU2 1710
      IF (DELTAX.LT.5.0E-5) DELTAX=5.0E-5                               SU2 1720
      DELTAY = ABS(SHIP(IOU,3)-RAID(IR,4))                              SU2 1730
      IF (DELTAY.LT.5.0E-5) DELTAY=5.0E-5                               SU2 1740
      TA = DELTAY**2+DELTAX**2                                          SU2 1750
      IF (TA.LE.TRGE) GO TO 250                                         SU2 1760
      GO TO 210                                                         SU2 1770
  250 NASM = NASM+1                                                     SU2 1780
  260 NTOT = NTOT-1                                                     SU2 1790
      MISLFT(IR,NOW) = MISLFT(IR,NOW)-1                                 SU2 1800
C                                                                       SU2 1810
C        FILL OUT THE ASM TABLE AND CHECK FOR SUCCESSFUL LAUNCH.        SU2 1820
C                                                                       SU2 1830
      M = NASM+90                                                       SU2 1840
      ASMT(NASM,3) = FLOAT(IR)                                          SU2 1850
      ASMT(NASM,4) = FLOAT(IOU)                                         SU2 1860
      ASMT(NASM,5) = TM                                                 SU2 1870
      ASMT(NASM,6) = FLOAT(J)                                           SU2 1880
      ASMT(NASM,7) = XU                                                 SU2 1890
      ASMT(NASM,8) = Y                                                  SU2 1900
      CALL RANDOM (ISEED,Z,1)                                           SU2 1910
      X(13) = X(13)+1.                                                  SU2 1920
      IF (Z.LT.RELI) GO TO 280                                          SU2 1930
      IF (X(3).EQ.1.) WRITE (6,1090) IR,NASM                            SU2 1940
      ASMT(NASM,1) = 0.                                                 SU2 1950
C                                                                       SU2 1960
      DO 270 K=1,NS                                                     SU2 1970
      NONO(M,K) = 1                                                     SU2 1980
  270 CONTINUE                                                          SU2 1990
C                                                                       SU2 2000
      DELTAX = ABS(SHIP(IOU,2)-RAID(IR,3))                              SU2 2010
      DELTAY = ABS(SHIP(IOU,3)-RAID(IR,4))                              SU2 2020
      IF (DELTAX.LT.AMF) DELTAX=AMF                                     SU2 2030
      IF (DELTAY.LT.AMF) DELTAY=AMF                                     SU2 2040
      ASMT(NASM,2) = TM+SQRT(DELTAY**2+DELTAX**2+(ALT/6000.)**2)/SPD    SU2 2050
      IF (IFLAG.EQ.1) GO TO 1060                                        SU2 2060
      IF (KING.EQ.1) IFLAG=1                                            SU2 2070
C                                                                       SU2 2080
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C        FLAG FOR TWO MISSILE SALVOS FOR SSN                                    SU2 2090
C                                                                               SU2 2100
      GO TO 870                                                                 SU2 2110
  280 XS = SHIP(IOU,2)                                                          SU2 2120
      ASMT(NASM,1) = 1.                                                         SU2 2130
C                                                                               SU2 2140
C        DETERMINE THE ASM/SSM FLIGHT TIME AND DETERMINE THE                    SU2 2150
C        IMPACT TIME.                                                           SU2 2160
C                                                                               SU2 2170
      RAID(IR,14) = XS                                                          SU2 2180
      YS = SHIP(IOU,3)                                                          SU2 2190
      RAID(IR,15) = YS                                                          SU2 2200
      XR = RAID(IR,3)                                                           SU2 2210
      YR = RAID(IR,4)                                                           SU2 2220
      DELTAX = ABS(XS-XR)                                                       SU2 2230
      IF (DELTAX.LT..00005) DELTAX=.00005                                       SU2 2240
      DELTAY = ABS(YS-YR)                                                       SU2 2250
      IF (DELTAY.LT..00005) DELTAY=.00005                                       SU2 2260
      DIST = SQRT(DELTAX**2+DELTAY**2+(ALT/6000.)**2)                           SU2 2270
      ASMT(NASM,2) = TM+DIST/SPD                                                SU2 2280
C                                                                               SU2 2290
C         STORE AN ASM IMPACT EVENT                                             SU2 2300
C                                                                               SU2 2310
      NU = M*100+IOU                                                            SU2 2320
      CALL STOREV (ASMT(NASM,2),4,NU)                                           SU2 2330
      ALTN2 = (ALT/6000.)**2                                                    SU2 2340
C                                                                               SU2 2350
C        ASM/SSM DETECTION AND FIRING ALGORITHM                                 SU2 2360
C                                                                               SU2 2370
      DO 860 K=1,NS                                                             SU2 2380
      NM = IFIX(SHIP(K,6)+AMF)                                                  SU2 2390
      IF (NM.GT.0) GO TO 290                                                    SU2 2400
      NONO(M,K) = 7                                                             SU2 2410
      GO TO 860                                                                 SU2 2420
  290 ISI = IFIX(SHIP(K,5)+AMF)                                                 SU2 2430
      RGE = 0.                                                                  SU2 2440
C                                                                               SU2 2450
C        GET MAX MISSILE RANGE FOR SAM SHIP                                     SU2 2460
C                                                                               SU2 2470
      DO 340 LO=1,4                                                             SU2 2480
      MP = 3+(LO-1)*3                                                           SU2 2490
C                                                                               SU2 2500
      DO 300 LI=1,3                                                             SU2 2510
      MPI = MP+LI                                                               SU2 2520
      IF (NADAR(K,MPI).GT.0) GO TO 310                                          SU2 2530
  300 CONTINUE                                                                  SU2 2540
C                                                                               SU2 2550
      GO TO 340                                                                 SU2 2560
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  310 IF (NADAR(K,(15+LO)).EQ.0) GO TO 340                              SU2 2570
      IC = IFIX(X(ISI+LO-1)+AMF)                                        SU2 2580
      IF (ALT.GT.X(77)) GO TO 320                                       SU2 2590
      ICS = 508+(IC-1)*40                                               SU2 2600
      GO TO 330                                                         SU2 2610
  320 ICS = 501+(IC-1)*40                                               SU2 2620
  330 SRGE = X(ICS)                                                     SU2 2630
      SVEL = X(ICS+1)                                                   SU2 2640
      IF (SRGE.LE.RGE) GO TO 340                                        SU2 2650
      RGE = SRGE                                                        SU2 2660
      L2 = LO                                                           SU2 2670
      SAMVEL = SVEL                                                     SU2 2680
  340 CONTINUE                                                          SU2 2690
C                                                                       SU2 2700
C        WILL THE ASM/SSM COME WITHIN THE BLUE MISSILE ENVELOPE?        SU2 2710
C                                                                       SU2 2720
      CALL TMDASM (IR,IOU,L2,K,SPD,RGE,TM,TD,XI,YI,RIP,TIML,NASM)       SU2 2730
      IF (TD.GE.9120.) GO TO 350                                        SU2 2740
      IF (TD.LT.X(82)) GO TO 360                                        SU2 2750
      NONO(M,K) = 8                                                     SU2 2760
      GO TO 860                                                         SU2 2770
  350 NONO(M,K) = 9                                                     SU2 2780
      GO TO 860                                                         SU2 2790
  360 IF (TD.LT.ASMT(NASM,2)) GO TO 370                                 SU2 2800
      NONO(M,K) = 6                                                     SU2 2810
      GO TO 860                                                         SU2 2820
  370 TFIR = TIML-RGE/SAMVEL                                            SU2 2830
C                                                                       SU2 2840
C        IS TIME TO FIRE AFTER TIME OF MISSILE EXITING ENVALOPE?        SU2 2850
C                                                                       SU2 2860
      IF (TFIR.GT.TD) GO TO 380                                         SU2 2870
      NONO(M,K) = 8                                                     SU2 2880
      GO TO 860                                                         SU2 2890
  380 KFLAG = 0                                                         SU2 2900
      TA = 0.                                                           SU2 2910
      TRGE = 1000.                                                      SU2 2920
      RGE = 0.                                                          SU2 2930
      JACK(K,1) = JACK(K,1)+1                                           SU2 2940
      JACK(K,6) = JACK(K,6)+1                                           SU2 2950
      NFOG = 0                                                          SU2 2960
      MFOG = 0                                                          SU2 2970
      JFOG = 0                                                          SU2 2980
C                                                                       SU2 2990
C         DETERMINE CPA OF ASM TO RADAR UNIT                            SU2 3000
C                                                                       SU2 3010
      CALL CPA (XU,Y,XS,YS,SHIP(K,2),SHIP(K,3),XCPA,YCPA)               SU2 3020
      RCPS = (SHIP(K,2)-XCPA)**2+(SHIP(K,3)-YCPA)**2+ALTN2              SU2 3030
C                                                                       SU2 3040
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      DO 460 NSR=1,3                                                    SU2 3050
      IF (NADAR(K,NSR).EQ.0) GO TO 460                                  SU2 3060
      KFLAG = 1                                                         SU2 3070
      ID = IFIX(X(ISI+3+NSR)+AMF)                                       SU2 3080
      IDI = (ID-1)*20                                                   SU2 3090
      IA = IFIX(X(901+IDI)+AMF)                                         SU2 3100
C                                                                       SU2 3110
C        BI-STATIC RADAR DETECTION MODE SWITCH                          SU2 3120
C                                                                       SU2 3130
      IF (IA.EQ.0) GO TO 930                                            SU2 3140
C                                                                       SU2 3150
C        MONOSTATIC SEARCH RADAR DETECTION RANGE ALGORITHM              SU2 3160
C                                                                       SU2 3170
      SRAG = X(902+IDI)*AREA                                            SU2 3180
      RRH = X(81)*SQRT(X(ISI+6+NSR))                                    SU2 3190
      HRAG = RRH+SALT                                                   SU2 3200
      THR = X(905+IDI)                                                  SU2 3210
      RG = AMIN1(SRAG,HRAG,THR)                                         SU2 3220
      IF (NJ.EQ.0) GO TO 390                                            SU2 3230
      IJI = IFIX(X(907+IDI)+AMF)                                        SU2 3240
      IF (JAM(IJI).EQ.0) GO TO 390                                      SU2 3250
      CALL JAMM (RG,K,IR,IJI,ID,SPD,RRH,AREA,1,ICPA,RGI)                SU2 3260
      IF (ICPA.EQ.0) GO TO 460                                          SU2 3270
      RAGJ = RGI                                                        SU2 3280
      GO TO 400                                                         SU2 3290
  390 RGS = RG**2                                                       SU2 3300
      IF (RCPS.GE.RGS) GO TO 460                                        SU2 3310
      RGI = RG                                                          SU2 3320
      RAGJ = 999.                                                       SU2 3330
  400 IF (X(3).EQ.0.) GO TO 410                                         SU2 3340
      WRITE (6,1110) K,M,NSR                                            SU2 3350
      WRITE (6,1120) SRAG,RAGJ,HRAG                                     SU2 3360
  410 CALL TMDASM (IR,IOU,NSR,K,SPD,RGI,TM,TI,XI,YI,RIP,TIML,NASM)      SU2 3370
  420 IF (TA.LT.TIML) TA = TIML                                         SU2 3380
      IF (X(10).EQ.0.) GO TO 430                                        SU2 3390
      DELR = (RIP*X(10))/SPD                                            SU2 3400
      GO TO 440                                                         SU2 3410
C        GET DETECTION DELAYS, CHECK TIMES, GET PROBABILITY OF DE-      SU2 3420
C        TECTION AND DETERMINE IF DETECTION OCCURRED.                   SU2 3430
C                                                                       SU2 3440
  430 KEY = IFIX(X(906+IDI)+AMF)                                        SU2 3450
      CALL REACT (1,KEY,DELR)                                           SU2 3460
  440 TDET = TI+DELR                                                    SU2 3470
      IF (TRGE.LE.TDET) GO TO 450                                       SU2 3480
      RGE = ABS(RIP-DELR*SPD)                                           SU2 3490
      TRGE = TDET                                                       SU2 3500
  450 IF (NFOG.GT.0) GO TO 960                                          SU2 3510
  460 CONTINUE                                                          SU2 3520
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C                                                                       SU2 3530
C        GO TO HORIZON SEARCH DETECTION MODE                            SU2 3540
C                                                                       SU2 3550
      IF (KFLAG.EQ.0) GO TO 740                                         SU2 3560
C                                                                       SU2 3570
C        WILL ASM/SSM ENTER SEARCH RADAR RANGE?                         SU2 3580
C                                                                       SU2 3590
      IF (TRGE.LT.TA) GO TO 470                                         SU2 3600
      IF (MFOG.GT.0) GO TO 960                                          SU2 3610
      NONO(M,K) = 2                                                     SU2 3620
      IF (X(3).EQ.1.) WRITE (6,1210) TA                                 SU2 3630
      GO TO 860                                                         SU2 3640
  470 RGFC = 0.                                                         SU2 3650
      JACK(K,7) = JACK(K,7)+1                                           SU2 3660
      STATS(K,2) = STATS(K,2)+RGE                                       SU2 3670
C                                                                       SU2 3680
C        FIRE CONTROL ACQUISITION PHASE                                 SU2 3690
C                                                                       SU2 3700
      DO 560 NB=1,4                                                     SU2 3710
      MTY = IFIX(X(ISI+NB-1)+AMF)                                       SU2 3720
      IF (MTY.EQ.0) GO TO 570                                           SU2 3730
      IF (X(536+(MTY-1)*40).EQ.1.) GO TO 560                            SU2 3740
      MTQ = NB+15                                                       SU2 3750
      IF (NADAR(K,MTQ).EQ.0) GO TO 560                                  SU2 3760
C                                                                       SU2 3770
      DO 550 NF=1,3                                                     SU2 3780
      NPQ = 3+(NB-1)*3+NF                                               SU2 3790
      NAD = NADAR(K,NPQ)+1                                              SU2 3800
      GO TO (550,480,520), NAD                                          SU2 3810
  480 IA = IFIX(X(516+NF*2+(MTY-1)*40)+AMF)                             SU2 3820
      IAI = (IA-1)*20                                                   SU2 3830
      SRFC = X(902+IAI)*AREA                                            SU2 3840
      THR = X(905+IAI)                                                  SU2 3850
      RRH = X(81)*SQRT(X(ISI+9+NB))                                     SU2 3860
      HRAG = RRH+SALT                                                   SU2 3870
      RG = AMIN1(SRFC,HRAG,THR)                                         SU2 3880
      IF (NJ.EQ.0) GO TO 490                                            SU2 3890
      IJI = IFIX(X(907+IAI)+AMF)                                        SU2 3900
      IF (JAM(IJI).EQ.0) GO TO 490                                      SU2 3910
      CALL JAMM (RG,K,IR,IJI,IA,SPD,RRH,AREA,1,ICPA,RGF)                SJ2 3920
      IF (ICPA.EQ.0) GO TO 550                                          SU2 3930
      RFCJ = RGI                                                        SU2 3940
      GO TO 500                                                         SU2 3950
  490 RGS = RG**2                                                       SU2 3960
      IF (RCPS.GE.RGS) GO TO 550                                        SU2 3970
      RGF = RG                                                          SU2 3980
      RFCJ = 999.                                                       SU2 3990
  500 IF (X(3).EQ.0.) GO TO 510                                         SU2 4000
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      WRITE (6,1130) K,M,NB,NF                                          SU2 4010
      WRITE (6,1120) SRFC,RFCJ,HRAG                                     SU2 4020
  510 IF (RGFC.GE.RGF) GO TO 550                                        SU2 4030
      RGFC = RGF                                                        SU2 4040
      IFC = NB                                                          SU2 4050
      IFA = NF                                                          SU2 4060
      GO TO 550                                                         SU2 4070
  520 MTZ = (MTY-1)*40                                                  SU2 4080
      IF (ALT.GT.X(77)) GO TO 530                                       SU2 4090
      RGM = X(508+MTZ)                                                  SU2 4100
      SVEL = X(509+MTZ)                                                 SU2 4110
      GO TO 540                                                         SU2 4120
  530 RGM = X(501+MTZ)                                                  SU2 4130
      SVEL = X(502+MTZ)                                                 SU2 4140
  540 RGF = RGM*(1+SPD/SVEL)                                            SU2 4150
      IF (RGFC.GE.RGF) GO TO 560                                        SU2 4160
      IFC = NB                                                          SU2 4170
      RGFC = RGF                                                        SU2 4180
      IFA = 0                                                           SU2 4190
      GO TO 560                                                         SU2 4200
  550 CONTINUE                                                          SU2 4210
C                                                                       SU2 4220
  560 CONTINUE                                                          SU2 4230
C                                                                       SU2 4240
  570 CALL TMDASM (IR,IOU,IFC,K,SPD,RGFC,TM,TFR,XI,YI,RIP,TIMF,NASM)    SU2 4250
      IF (X(3).EQ.0.) GO TO 590                                         SU2 4260
      IF (JFOG.EQ.1) GO TO 580                                          SU2 4270
      WRITE (6,1140) TRGE,TFR                                           SU2 4280
      GO TO 590                                                         SU2 4290
  580 WRITE (6,1150) TRGE,TFR                                           SU2 4300
  590 PROB = X(ISI+15)                                                  SU2 4310
      CALL RANDOM (ISEED,Z,1)                                           SU2 4320
      X(13) = X(13)+1.                                                  SU2 4330
      IF (PROB.GT.Z) GO TO 600                                          SU2 4340
      NCNO(M,K) = 3                                                     SU2 4350
      GO TO 860                                                         SU2 4360
C                                                                       SU2 4370
C        DESIGNATION, EVALUATION, AND ACQUISITION DELAYS.               SU2 4380
C                                                                       SU2 4390
  600 IF (TA.LT.TFR) GO TO 940                                          SU2 4400
      KEY = IFIX(X(ISI+16)+AMF)                                         SU2 4410
      CALL REACT (2,KEY,TWDS)                                           SU2 4420
      KEY = IFIX(X(ISI+17)+AMF)                                         SU2 4430
      CALL REACT (3,KEY,TDES)                                           SU2 4440
      MTY = IFIX(X(ISI+IFC-1)+AMF)                                      SU2 4450
      MTZ = (MTY-1)*40                                                  SU2 4460
      IF (IFA.EQ.0) GO TO 610                                           SU2 4470
      IA = IFIX(X(516+IFA*2+MTZ)+AMF)                                   SU2 4480
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      KEY = IFIX(X(906+(IA-1)*20)+AMF)                                  SU2 4490
      CALL REACT (4,KEY,TAC)                                            SU2 4500
      TSR = TRGE+TWDS+TDES+TAC                                          SU2 4510
      GO TO 620                                                         SU2 4520
  610 TSR = TRGE+TWDS+TDES                                              SU2 4530
  620 IF (ALT.GT.X(77)) GO TO 630                                       SU2 4540
      SVEL = X(509+MTZ)                                                 SU2 4550
      GO TO 640                                                         SU2 4560
  630 SVEL = X(502+MTZ)                                                 SU2 4570
  640 TLS = TIMF-RGFC/SVEL                                              SU2 4580
      IF (TSR.LT.TLS) GO TO 650                                         SU2 4590
      IF (MFOG.GT.0) GO TO 960                                          SU2 4600
      NONO(M,K) = 5                                                     SU2 4610
      GO TO 860                                                         SU2 4620
C                                                                       SU2 4630
C        FIRE EVENT STORAGE FOR A REGULAR SHOT                          SU2 4640
C                                                                       SU2 4650
  650 KEY = IFIX(X(ISI+18)+AMF)                                         SU2 4660
      CALL REACT (5,KEY,TFIRE)                                          SU2 4670
      IF (TRGE.GT,TFR) GO TO 660                                        SU2 4680
      TSHOOT = TFR+TFIRE                                                SU2 4690
      GO TO 670                                                         SU2 4700
  660 TSHOOT = TSR+TFIRE                                                SU2 4710
  670 IF (X(57).EQ.0.) GO TO 680                                        SU2 4720
      WRITE (6,1220) TSHOOT,DELR,TWDS                                   SU2 4730
      WRITE (6,1230) TDES,TFIRE                                         SU2 4740
  680 IF (TSHOOT.LT.TLS) GO TO 690                                      SU2 4750
      IF (MFOG.GT.0) GO TO 960                                          SU2 4760
      NONO(M,K) = 5                                                     SU2 4770
      GO TO 860                                                         SU2 4780
C                                                                       SU2 4790
  690 DO 720 MS=1,4                                                     SU2 4800
      MJL = 15+MS                                                       SU2 4810
      IF (NADAR(K,MJL).EQ.0) GO TO 720                                  SU2 4820
      ID = IFIX(X(ISI+MS-1)+AMF)                                        SU2 4830
      IF (X(536+(ID-1)*40).EQ.1.) GO TO 720                             SU2 4840
      MP = 3+(MS-1)*3                                                   SU2 4850
C                                                                       SU2 4860
      DO 710 MT=1,3                                                     SU2 4870
      MPI = MP+MT                                                       SU2 4880
      LARRY = NADAR(K,MPI)+1                                            SU2 4890
      GO TO (710,700,730,710), LARRY                                    SU2 4900
  700 KS3 = M*100000+K*1000+MS*100+MT*10                                SU2 4910
      CALL STOREV (TSHOOT,3,KS3)                                        SU2 4920
  710 CONTINUE                                                          SU2 4930
C                                                                       SU2 4940
  720 CONTINUE                                                          SU2 4950
C                                                                       SU2 4960
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      GO TO 860                                                         SU2 4970
C                                                                       SU2 4980
C        FIRE EVENT STORAGE FOR A NON DEDICATED SHOT                    SU2 4990
C                                                                       SU2 5000
  730 KS3 = M*100000+K*1000+MS*100+MT*10+7                              SU2 5010
      CALL STOREV (TSHOOT,3,KS3)                                        SU2 5020
      GO TO 720                                                         SU2 5030
  740 RGFC = 0.                                                         SU2 5040
C                                                                       SU2 5050
C        HORIZON SEARCH DETECTION ALGORITHM                             SU2 5060
C                                                                       SU2 5070
      DO 790 NB=1,4                                                     SU2 5080
      IF (X(ISI+NB-1).EQ.0.) GO TO 790                                  SU2 5090
      ICH = (NB-1)*3+3                                                  SU2 5100
C                                                                       SU2 5110
      DO 780 NF=1,3                                                     SU2 5120
      NFG = ICH+NF                                                      SU2 5130
      IF (NADAR(K,NFG).NE.3) GO TO 780                                  SU2 5140
      IFCR = IFIX(X(ISI+NB-1)+AMF)                                      SU2 5150
      ICL = IFIX(X(516+(IFCR-1)*40+2*NF)+AMF)                           SU2 5160
      ICI = (ICL-1)*20                                                  SU2 5170
      RRFC = X(902+ICI)*AREA                                            SU2 5180
      THR = X(905+ICI)                                                  SU2 5190
      HT = X(ISI+10+NF)                                                 SU2 5200
      RRH = X(81)*SQRT(HT)                                              SU2 5210
      HORZ = RRH+SALT                                                   SU2 5220
      RG = AMIN1(RRFC,HORZ,THR)                                         SU2 5230
      IF (NJ.EQ.0) GO TO 750                                            SU2 5240
      IJI = IFIX(X(907+ICI)+AMF)                                        SU2 5250
      IF (JAM(IJI).EQ.0) GO TO 750                                      SU2 5260
      CALL JAMM (RG,K,IR,IJI,ICL,SPD,RRH,AREA,1,ICPA,RGF)               SU2 5270
      IF (ICPA.EQ.0) GO TO 780                                          SU2 5280
      RFCJ = RGF                                                        SU2 5290
      GO TO 760                                                         SU2 5300
  750 RGS = RG**2                                                       SU2 5310
      IF (RCPS.GE.RGS) GO TO 780                                        SU2 5320
      RGF = RG                                                          SU2 5330
      RFCJ = 999.                                                       SU2 5340
  760 IF (X(57).EQ.0.) GO TO 770                                        SU2 5350
      WRITE (6,1160) K,M                                                SU2 5360
      WRITE (6,1120) RRFC,RFCJ,HORZ                                     SU2 5370
  770 IF (RGF.LE.RGFC) GO TO 780                                        SU2 5380
      IF (RGF.LE.RGFC) GO TO 780                                        SU2 5390
      RGFC = RGF                                                        SU2 5400
      IFC = NB                                                          SU2 5410
      IFA = NF                                                          SU2 5420
  780 CONTINUE                                                          SU2 5430
C                                                                       SU2 5440
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  790 CONTINUE                                                                    SU2 5450
C                                                                                 SU2 5460
      MTY = IFIX(X(ISI-1+IFC)+AMF)                                                SU2 5470
      MTZ = (MTY-1)*40                                                            SU2 5480
      IA = IFIX(X(516+IFA*2+MTZ)+AMF)                                             SU2 5490
C                                                                                 SU2 5500
C        HORIZON SEARCH DECISION AND FIRE DELAYS                                  SU2 5510
C                                                                                 SU2 5520
      KEY = IFIX(X(908+(IA-1)*20)+AMF)                                            SU2 5530
      CALL REACT (6,KEY,TAC)                                                      SU2 5540
      KEY = IFIX(X(ISI+18)+AMF)                                                   SU2 5550
      CALL REACT (5,KEY,TFIRE)                                                    SU2 5560
      KEY = IFIX(X(ISI+19)+AMF)                                                   SU2 5570
      CALL REACT (7,KEY,THSCAN)                                                   SU2 5580
      CALL TMDASM (IR,IOU,IFC,K,SPD,RGFC,TM,TIFA,XI,YI,RIP,TIML,NASM)             SU2 5590
      TSHOOT = TIFA+TAC+AMAX1(TFIRE,THSCAN)                                       SU2 5600
      IF (TSHOOT.GT.X(82)) GO TO 800                                              SU2 5610
      STATS(K,2) = STATS(K,2)+RIP                                                 SU2 5620
      JACK(K,7) = JACK(K,7)+1                                                     SU2 5630
      IF (ALT.GT.X(77)) GO TO 810                                                 SU2 5640
      SVEL = X(508+MTZ)                                                           SU2 5650
      GO TO 820                                                                   SU2 5660
  800 NCNO(M,K) = 4                                                               SU2 5670
      GO TO 860                                                                   SU2 5680
  810 SVEL = X(502+MTZ)                                                           SU2 5690
  820 TLS = TIML-RGFC/SVEL                                                        SU2 5700
      IF (TSHOOT.LE.TLS) GO TO 830                                                SU2 5710
      NCNO(M,K) = 5                                                               SU2 5720
      GO TO 860                                                                   SU2 5730
C                                                                                 SU2 5740
C        HORIZON SEARCH FIRE                                                      SU2 5750
C                                                                                 SU2 5760
  830 DO 850 MS=1,4                                                               SU2 5770
      IPQ = 15+MS                                                                 SU2 5780
      IF (NADAR(K,IPQ).EQ.0) GO TO 850                                            SU2 5790
      ID = IFIX(X(ISI+MS-1)+AMF)                                                  SU2 5800
      IF (X(536+(ID-1)*40).EQ.1.) GO TO 850                                       SU2 5810
      MP = 3+(MS-1)*3                                                             SU2 5820
C                                                                                 SU2 5830
      DO 840 MT=1,3                                                               SU2 5840
      MPI = MP+MT                                                                 SU2 5850
      IF (NADAR(K,MPI).NE.3) GO TO 840                                            SU2 5860
      KS3 = M*100000+K*1000+MS*100+MT*10                                          SU2 5870
      CALL STOREV (TSHOOT,3,KS3)                                                  SU2 5880
  840 CONTINUE                                                                    SU2 5890
C                                                                                 SU2 5900
  850 CONTINUE                                                                    SU2 5910
C                                                                                 SU2 5920
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  860 CONTINUE                                                        SU2 5930
C                                                                     SU2 5940
      IF (IFLAG.EQ.1) GO TO 1060                                      SU2 5950
      IF (KING.EQ.1) IFLAG=1                                          SU2 5960
  870 CONTINUE                                                        SU2 5970
C                                                                     SU2 5980
C        CHECK TO SEE IF THE RAIDER HAS ANOTHER TYPE OF MISSILE       SU2 5990
C                                                                     SU2 6000
      IF (NTOT.EQ.0) GO TO 900                                        SU2 6010
      IF (NEXT.EQ.1) GO TO 880                                        SU2 6020
      IF (RAID(IR,16).GT.TM) GO TO 890                                SU2 6030
      NMIS = MISLFT(IR,2)                                             SU2 6040
      NOW = 2                                                         SU2 6050
      KATHY = 1                                                       SU2 6060
      GO TO 60                                                        SU2 6070
  880 IF (RAID(IR,16).GT.TM) GO TO 890                                SU2 6080
      NMIS = MISLFT(IR,1)                                             SU2 6090
      NOW = 1                                                         SU2 6100
      KATHY = 1                                                       SU2 6110
      GO TO 60                                                        SU2 6120
  890 IF (RAID(IR,16).GT.X(82)) GO TO 900                             SU2 6130
C                                                                     SU2 6140
C        IF THE RAIDER IS OUTSIDE THE LAUNCH RANGE FOR THE TYPE       SU2 6150
C        TWO MISSILES, STORE A MISSILE (ASM/SSM) LAUNCH EVENT         SU2 6160
C                                                                     SU2 6170
      CALL STOREV (RAID(IR,16),2,IR)                                  SU2 6180
C                                                                     SU2 6190
C        IF  FLAG SET PRINT THE NONO TABLE                            SU2 6200
C                                                                     SU2 6210
  900 IF (X(58).EQ.0.) GO TO 910                                      SU2 6220
      WRITE (6,1190)                                                  SU2 6230
      NMIS = 90+NASM                                                  SU2 6240
      WRITE (6,1200) (MFOG,(NONO(MFOG,NFOG),NFOG=1,40),MFOG=1,NR)     SU2 6250
      WRITE (6,1200) (MFOG,(NONO(MFOG,NFOG),NFOG=1,40),MFOG=91,NMIS)  SU2 6260
  910 IF (X(55).EQ.0.) GO TO 920                                      SU2 6270
      CALL GETIMX (IET)                                               SU2 6280
      T = .000026*IET                                                 SU2 6290
      WRITE (6,1170) T                                                SU2 6300
  920 RETURN                                                          SU2 6310
C        THE BI-STATIC DETECTION ALGORITHM                            SU2 6320
C                                                                     SU2 6330
  930 CALL BIDET (K,NSR,ALT,IR,SPD,SIGMA,ND,TI,TIML,RGI,TD2,TIML2,R2,1) SU2 6340
      ND = ND+1                                                       SU2 6350
      GO TO (950,420,1000), ND                                        SU2 6360
  940 NONO(M,K) = 4                                                   SU2 6370
      GO TO 860                                                       SU2 6380
  950 TI = 9120.                                                      SU2 6390
      TIML = 0.                                                       SU2 6400
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```
      TA = 0.                                                           SU2 6450
      GO TO (970,980,990), MFOG                                         SU2 6460
  970 TI = TTA                                                          SU2 6470
      TIML = TIMLA                                                      SU2 6480
      RGI = RGIA                                                        SU2 6490
      MFOG = MFOG-1                                                     SU2 6500
      JFOG = 1                                                          SU2 6510
      NFOG = 0                                                          SU2 6520
      GO TO 420                                                         SU2 6530
  980 TI = TTB                                                          SU2 6540
      TIML = TIMLB                                                      SU2 6550
      RGI = RGIB                                                        SU2 6560
      MFOG = MFOG-1                                                     SU2 6570
      GO TO 420                                                         SU2 6580
  990 TI = TTC                                                          SU2 6590
      RGI = RGIC                                                        SU2 6600
      TIML = TIMLC                                                      SU2 6610
      MFOG = MFOG-1                                                     SU2 6620
      GO TO 420                                                         SU2 6630
 1000 MFOG = MFOG+1                                                     SU2 6640
      GO TO (1010,1020,1030), MFOG                                      SU2 6650
 1010 TTA = TD2                                                         SU2 6660
      TIMLA = TIML2                                                     SU2 6670
      RGIA = R2                                                         SU2 6680
      GO TO 420                                                         SU2 6690
 1020 TTB = TD2                                                         SU2 6700
      TIMLB = TIML2                                                     SU2 6710
      NFOG = 1                                                          SU2 6720
      RGIB = R2                                                         SU2 6730
      GO TO 420                                                         SU2 6740
 1030 TTC = TD2                                                         SU2 6750
      TIMLC = TIML2                                                     SU2 6760
      RGIC = R2                                                         SU2 6770
      GO TO 420                                                         SU2 6780
 1040 IF (IFLASK.EQ.1) IFLASK=0                                         SU2 6790
      NTOT = MISLFT(IR,1)+MISLFT(IR,2)                                  SU2 6800
      JFLAG = 1                                                         SU2 6810
      ID = IFIX(X(2201+(IR-1)*6)+AMF)                                   SU2 6820
      KING = IFIX(X(1808+(ID-1)*20)+AMF)                                SU2 6830
      IF (KING.EQ.1) IFLAG=1                                            SU2 6840
      CALL RANDOM (ISEED,Z,1)                                           SU2 6850
      X(13) = X(13)+1.                                                  SU2 6860
      TX = X(86)*Z                                                      SU2 6870
      GO TO 40                                                          SU2 6880
```

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      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMSU3     60
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEESU3     70
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOSU3     80
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QSU3     90
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),SU3    100
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4SU3    110
     60),AMF,HISX(100),JACK(40,7),HISA(100)                              SU3    120
C                                                                        SU3    130
      MFOG = 0                                                           SU3    140
      NC1 = 0                                                            SU3    150
      REASON = 0.                                                        SU3    160
      IF (X(55).EQ.0.) GO TO 20                                          SU3    170
      CALL GETIMX (K)                                                    SU3    180
      TIM = K*0.000026                                                   SU3    190
      WRITE (6,610) TIM                                                  SU3    200
C                                                                        SU3    210
C         DETERMINE THE TARGET NUMBER, FIRING SHIP,BATTERY,DIRECTOR,     SU3    220
C         AND CHANNEL NUMBER FOR THE PROPOSED MISSILE FIRING.            SU3    230
C                                                                        SU3    240
   20 IU = IU+2                                                          SU3    250
      M = IU*1.0D-5                                                      SU3    260
      KP = M*100000                                                      SU3    270
      ID = IU-KP                                                         SU3    280
      K = ID*1.0D-3                                                      SU3    290
      KP = K*1000                                                        SU3    300
      JP = ID-KP                                                         SU3    310
      NMS = JP*0.0100                                                    SU3    320
      KP = NMS*100                                                       SU3    330
      ID = JP-KP                                                         SU3    340
      NB = ID*0.10                                                       SU3    350
      KP = NB*10                                                         SU3    360
      NC = ID-KP                                                         SU3    370
      NC = NC-2                                                          SU3    380
      IU = IU-2                                                          SU3    390
C                                                                        SU3    400
C         IF THE FIRING SHIP HAS BEEN SUNK,EXIT                          SU3    410
C                                                                        SU3    420
      IF (SHIP(K,6).NE.0.) GO TO 30                                      SU3    430
      REASON = 1.                                                        SU3    440
      GO TO 560                                                          SU3    450
C                                                                        SU3    460
C         IF THE FIRING SHIP IS OUT OF MISSILES, EXIT                    SU3    470
C                                                                        SU3    480
   30 IF (IBAT(K,NMS).NE.0) GO TO 40                                     SU3    490
      REASON = 4.                                                        SU3    500
      GO TO 560                                                          SU3    510
C                                                                        SU3    520
C         IF THE TARGET HAS ALREADY BEEN SUNK OR SHOT DOWN, EXIT         SU3    530
```

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C        IF THE RAIDER WAS AN AIRCRAFT CARRYING ASMS AND ALL ITS        SU3  540
C        ASMS HAVE BEEN LAUNCHED, AND THE FLAG IS SET, EXIT             SU3  550
C                                                                       SU3  560
   40 IF (M.GT.90) GO TO 60                                             SU3  570
      IF (RAID(M,13).NE.0.) GO TO 70                                    SU3  580
   50 REASON = 3.                                                       SU3  590
      GO TO 560                                                         SU3  600
   60 JULIA = M-90                                                      SU3  610
      IF (ASMT(JULIA,1).NE.1.) GO TO 50                                 SU3  620
C                                                                       SU3  630
C        GET THE MAXIMUM MISSILE RANGE FOR THIS BATTERY AND CHECK       SU3  640
C        TO SEE IF THERE ARE ANY TARGETS MORE THREATENING WHICH         SU3  650
C        IT IS CAPABLE OF HANDLING                                      SU3  660
C                                                                       SU3  670
   70 ID = IFIX(SHIP(K,5)+AMF)                                          SU3  680
      ID = IFIX(X(ID+NMS-1)+AMF)                                        SU3  690
      KING = (ID-1)*40                                                  SU3  700
      RGE = AMAX1(X(501+KING),X(508+KING))                              SU3  710
      IF (M.GT.90) GO TO 80                                             SU3  720
      CALL LOCTIM (M,TIME,5,XP,YP)                                      SU3  730
      CALL CPA (XP,YP,RAID(M,5),RAID(M,6),SHIP(K,2),SHIP(K,3),RJL,EBTJR)SU3  740
      GO TO 90                                                          SU3  750
   80 LML = IFIX(ASMT(JULIA,4)+AMF)                                     SU3  760
      CALL ASMTIM (M,TIME,XP,YP)                                        SU3  770
      CALL CPA (XP,YP,SHIP(LML,2),SHIP(LML,3),SHIP(K,2),SHIP(K,3),RJL,EBSU3  780
     1TJR)                                                              SU3  790
   90 TT = (RJL-SHIP(K,2))**2+(EBTJR-SHIP(K,3))**2                      SU3  800
      IF (TT.LE.RGE**2) GO TO 100                                       SU3  810
      REASON = 13.                                                      SU3  820
      GO TO 560                                                         SU3  830
  100 TT = X(532+KING)                                                  SU3  840
      CALL PRIOR (M,K,NMS,NB,RGE,NC,TIME,M1,NC1,XP,YP)                  SU3  850
C                                                                       SU3  860
C       IS NEW TARGET THE SAME AS THE OLD, OR HAS NEW BEEN DESTROYED?   SU3  870
C                                                                       SU3  880
      IF (M1.EQ.M) GO TO 120                                            SU3  890
      IF (M1.GT.90) GO TO 110                                           SU3  900
      IF (RAID(M1,13).EQ.0.) GO TO 50                                   SU3  910
      GO TO 120                                                         SU3  920
  110 JULIA = M1-90                                                     SU3  930
      IF (ASMT(JULIA,1).NE.1.) GO TO 50                                 SU3  940
C                                                                       SU3  950
C        IF THERE IS COORDINATION,CHECK TO SEE IF THE TARGET IS         SU3  960
C        AVAILABLE                                                      SU3  970
C                                                                       SU3  980
  120 IF (X(4).EQ.0.) GO TO 140                                         SU3  990
      KP = IFIX(SHIP(K,5)+AMF)                                          SU3 1000
      IF (X(KP+14).EQ.0.) GO TO 140                                     SU3 1010
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      IF (TIME.GT.TGTAV(M1)) GO TO 140                                  SU3 1020
      REASON = 2.                                                       SU3 1030
      T = TGTAV(M1)+1.0E-3                                              SU3 1040
  130 KP = M1*100000+K*1000+NMS*100+NB*10+NC1                           SU3 1050
      CALL STOREV (T,3,KP)                                              SU3 1060
      GO TO 560                                                         SU3 1070
  140 IF (NONO(M1,K).EQ.0) GO TO 150                                    SU3 1080
      REASON = 8.                                                       SU3 1090
      GO TO 560                                                         SU3 1100
C                                                                       SU3 1110
C        FLAG ICOT SET TO 1 IF A)  CHANNEL PREVIOUSLY ASSIGNED AND      SU3 1120
C        THAT CHANNEL IS BUSY,    B) NO CHANNEL PREVIOUSLY ASSIGNED     SU3 1130
C        ALL CHANNELS ARE BUSY, EARLIEST AVAILABLE ASSIGNED, AND THE    SU3 1140
C        MISSILE ONLY REQUIRES THE DIRECTOR FOR THE FINAL PHASE         SU3 1150
C        OF THE INTERCEPT.                                              SU3 1160
C        THE FLAG ICOT IS SET TO 0 IF THE MISSILE REQUIRES NO           SU3 1170
C        DIRECTOR, OR IF THE CHANNEL ASSIGNED IS FREE.                  SU3 1180
C                                                                       SU3 1190
  150 NCH = IFIX(X(515+KING+NB*2)+AMF)                                  SU3 1200
      IF (NC1.EQ.7) GO TO 250                                           SU3 1210
      IF (NC1.EQ.0) GO TO 160                                           SU3 1220
      IF (CHANEL(K,NMS,NB,NC1).EQ.0.) GO TO 250                         SU3 1230
      GO TO 180                                                         SU3 1240
C                                                                       SU3 1250
  160 DO 170 I=1,NCH                                                    SU3 1260
      IF (CHANEL(K,NMS,NB,I).EQ.0.) GO TO 240                           SU3 1270
  170 CONTINUE                                                          SU3 1280
C                                                                       SU3 1290
  180 TA = 5000.                                                        SU3 1300
      KP = 0                                                            SU3 1310
      I = NSAM                                                          SU3 1320
  190 KA = IFIX(SMAT(I,2)+AMF)                                          SU3 1330
      IF (KA.NE.K) GO TO 220                                            SU3 1340
      KA = IFIX(SAMASM(I,2)*1.0E-1+AMF)                                 SU3 1350
      T = FLOAT(KA)                                                     SU3 1360
      KA = IFIX(SAMASM(I,2)-T*10.+AMF)                                  SU3 1370
      IF (KA.NE.NMS) GO TO 220                                          SU3 1380
      KA = IFIX(SAMASM(I,3)*1.0E-1+AMF)                                 SU3 1390
      IF (KA.NE.NB) GO TO 220                                           SU3 1400
C                                                                       SU3 1410
      DO 200 J=1,NCH                                                    SU3 1420
      KA = J+3                                                          SU3 1430
      TIM = SMAT(I,KA)                                                  SU3 1440
      IF (TA.LE.TIM) GO TO 200                                          SU3 1450
      JAPL = J                                                          SU3 1460
      TA = TIM                                                          SU3 1470
  200 CONTINUE                                                          SU3 1480
C                                                                       SU3 1490
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      NC1 = JAPL                                                        SU3 1500
      IF (TT.GT.0.) GO TO 260                                           SU3 1510
      T = TA+1.0E-3                                                     SU3 1520
      KP = 3+(NMS-1)*3+NB                                               SU3 1530
      IF (NADAR(K,KP).EQ.3) GO TO 210                                   SU3 1540
      REASON = 5.                                                       SU3 1550
      GO TO 130                                                         SU3 1560
  210 REASON = 12.                                                      SU3 1570
      GO TO 130                                                         SU3 1580
  220 I = I-1                                                           SU3 1590
      IF (I.NE.0) GO TO 190                                             SU3 1600
  230 WRITE (6,620) K,NMS,NB                                            SU3 1610
      STOP                                                              SU3 1620
  240 NC1 = I                                                           SU3 1630
  250 TA = TIME                                                         SU3 1640
      ICOT = 0                                                          SU3 1650
      GO TO 270                                                         SU3 1660
  260 ICOT = 1                                                          SU3 1670
C                                                                       SU3 1680
C         CHECK TO SEE IF OWN SHIP IS ENGAGING THE TARGET WITH ANOTHER  SU3 1690
C         SYSTEM                                                        SU3 1700
C                                                                       SU3 1710
  270 DO 280 I=1,300                                                    SU3 1720
      IF (SAMASM(I,1).EQ.0.) GO TO 300                                  SU3 1730
      LML = IFIX(SAMASM(I,1)+AMF)                                       SU3 1740
      IF (LML.NE.M1) GO TO 280                                          SU3 1750
      LML = IFIX(SAMASM(I,2)*1.0E-1+AMF)                                SU3 1760
      IF (LML.NE.K) GO TO 280                                           SU3 1770
      IF (SAMASM(I,6).GT.TIME) GO TO 290                                SU3 1780
  280 CONTINUE                                                          SU3 1790
C                                                                       SU3 1800
      GO TO 300                                                         SU3 1810
  290 REASON = 6.                                                       SU3 1820
      GO TO 560                                                         SU3 1830
  300 IF (M1.LE.90) GO TO 320                                           SU3 1840
C                                                                       SU3 1850
C         CHECK TO SEE IF ASM WILL IMPACT BEFORE LAUNCH OF SAM.         SU3 1860
C                                                                       SU3 1870
      IF (ASMT(JULIA,2).GE.TA) GO TO 320                                SU3 1880
  310 REASON = 10.                                                      SU3 1890
      GO TO 560                                                         SU3 1900
C                                                                       SU3 1910
C         CHECK TO SEE IF LAUNCHER IS LOADED                            SU3 1920
C                                                                       SU3 1930
  320 IF (RELOAD(K,NMS).LE.TIME) GO TO 340                              SU3 1940
      REASON = 9.                                                       SU3 1950
      IF (M1.LE.90) GO TO 330                                           SU3 1960
      IF (RELOAD(K,NMS).GE.ASMT(JULIA,2)) GO TO 310                     SU3 1970
```

```
  330 T = RELOAD(K,NMS)                                                SU3 1980
      GO TO 130                                                        SU3 1990
  340 IF (ICOT.EQ.0) GO TO 380                                         SU3 2000
      I = NSAM                                                         SU3 2010
C                                                                      SU3 2020
C         IF SAM/SSM CHANNELS BUSY STORE A SHOOT EVENT WHEN THE CHANNEL SU3 2030
C         WILL BE FREE                                                 SU3 2040
C                                                                      SU3 2050
  350 LML = IFIX(SAMASM(I,2)*1.0E-1+AMF)                               SU3 2060
      IF (LML.NE.K) GO TO 360                                          SU3 2070
      T = FLOAT(LML)                                                   SU3 2080
      KP = IFIX(SAMASM(I,2)-T*10.+AMF)                                 SU3 2090
      IF (KP.NE.NMS) GO TO 360                                         SU3 2100
      LML = IFIX(SAMASM(I,3)*1.0E-1+AMF)                               SU3 2110
      IF (LML.NE.NB) GO TO 360                                         SU3 2120
      T = FLOAT(LML)                                                   SU3 2130
      KP = IFIX(SAMASM(I,3)-T*10.+AMF)                                 SU3 2140
      IF (KP.EQ.NC1) GO TO 370                                         SU3 2150
  360 I = I-1                                                          SU3 2160
      IF (I.NE.0) GO TO 350                                            SU3 2170
      GO TO 230                                                        SU3 2180
  370 T = SAMASM(I,6)+1.0E-3                                           SU3 2190
      REASCN = 7.                                                      SU3 2200
      GO TO 130                                                        SU3 2210
C                                                                      SU3 2220
C         CHECK TO SEE IF, IN FACT THIS MISSILE CAN INTERCEPT          SU3 2230
C         A TARGET WITH ITS FLIGHT CHARACTERISTICS                     SU3 2240
C                                                                      SU3 2250
  380 CALL TIMMY (M1,K,NMS,XP,YP,PROB,FT,KP,TIME)                      SU3 2260
C                                                                      SU3 2270
C         IF IND RETURNS FROM TIMMY WITH A VALUE OF 1, THE INTERCEPT   SU3 2280
C         IS POSSIBLE                                                  SU3 2290
C                                                                      SU3 2300
      IF (KP) 390,410,420                                              SU3 2310
  390 REASON = 14.                                                     SU3 2320
  400 T = TIME+0.1                                                     SU3 2330
      GO TO 130                                                        SU3 2340
  410 REASON = 13.                                                     SU3 2350
      GO TO 560                                                        SU3 2360
  420 IF (KP.EQ.1) GO TO 430                                           SU3 2370
      REASON = 15.                                                     SU3 2380
      GO TO 400                                                        SU3 2390
  430 IF (TT.EQ.0.) GO TO 500                                          SU3 2400
      IF (NSAM.EQ.0) GO TO 500                                         SU3 2410
C                                                                      SU3 2420
C         IF THE SYSTEM REQUIRES THE DIRECTOR ONLY PART TIME,          SU3 2430
C         CHECK TO SEE IF THE DIRECTOR WILL BE AVAILABLE WHEN NEEDED   SU3 2440
C                                                                      SU3 2450
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```
      KIM = K*100+NMS*10+NB
      TG = TIME+FT-TT
      TL = TIME+FT
      TFT = 9000.
      I = NSAM
  440 IF (I.EQ.0) GO TO 490
      ID = IFIX(SAMASM(I,2)*10.+AMF)+IFIX(SAMASM(I,3)*1.0E-1+AMF)
      IF (KIM.EQ.ID) GO TO 450
      I = I-1
      GO TO 440
  450 NC2 = NC1+3
      IPQ = NCH+3
C
      DO 470 ID=4,IPQ
      IF (ID.EQ.NC2) GO TO 470
      IF (SMAT(I,ID).LT.TG) GO TO 460
      T = SMAT(I,ID)-TT
      IF (T.GT.TL) GO TO 460
      GO TO 480
  460 TCF(ID-3) = SMAT(I,ID)
  470 CONTINUE
C
      GO TO 490
  480 IF (TFT.LT.SMAT(I,ID)) GO TO 460
      MFOG = 1
      TFT = SMAT(I,ID)
      GO TO 460
  490 IF (MFOG.EQ.0) GO TO 500
      REASON = 11.
      T = TFT-FT+TT+1.0E-3
      GO TO 130
C
C        IF OK, FILL IN THE SAMASM AND SAM TABLES, LOG THE
C        CHANNEL BUSY, STORE THE INTERCEPT EVENT
C
  500 MFOG = IFIX(X(524+KING)+AMF)
      NSAM = NSAM+1
      IF (NSAM.GT.300) GO TO 600
      I = NSAM
      SAMASM(I,1) = FLOAT(M1)
      SAMASM(I,7) = PROB
      SAMASM(I,2) = FLOAT(K*10+NMS)
      SAMASM(I,3) = FLOAT(NB*10+NC1)
      SAMASM(I,4) = TIME
      SAMASM(I,6) = TIME+FT
      CALL STOREV (SAMASM(I,6),5,I)
      IBAT(K,NMS) = IBAT(K,NMS)-MFOG
      SMAT(I,10) = FLOAT(MFOG)
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      X(75) = X(75)-X(524+KING)                                         SU3 2940
      IF (X(4).EQ.0.) GO TO 510                                         SU3 2950
      KP = IFIX(SHIP(K,5)+AMF)                                          SU3 2960
      IF (X(KP+14).EQ.0.) GO TO 510                                     SU3 2970
      TGTAV(M1) = TIME+FT                                               SU3 2980
  510 RLT = X(525+KING)                                                 SU3 2990
      RELOAD(K,NMS) = TIME+RLT                                          SU3 3000
      IP = IFIX(SHIP(K,5)+AMF)                                          SU3 3010
      IP = IFIX(X(IP+NMS-1)+AMF)                                        SU3 3020
      SMAT(I,1) = FLOAT(IP)                                             SU3 3030
      SMAT(I,2) = FLOAT(K)                                              SU3 3040
      ID = IBAT(K,NMS)                                                  SU3 3050
      SMAT(I,3) = FLOAT(ID)                                             SU3 3060
      IF (TT.EQ.0.) GO TO 540                                           SU3 3070
C                                                                       SU3 3080
      DO 520 J=1,NCH                                                    SU3 3090
      JP = J+3                                                          SU3 3100
      IF (J.EQ.NC1) GO TO 530                                           SU3 3110
      SMAT(I,JP) = TCF(J)                                               SU3 3120
  520 CONTINUE                                                          SU3 3130
C                                                                       SU3 3140
      GO TO 550                                                         SU3 3150
  530 SMAT(I,JP) = TIME+FT                                              SU3 3160
      GO TO 520                                                         SU3 3170
  540 SMAT(I,4) = TIME+FT                                               SU3 3180
  550 REASON = 0.                                                       SU3 3190
      IF (NC1.EQ.7) GO TO 560                                           SU3 3200
      CHANEL(K,NMS,NB,NC1)=1.                                           SU3 3210
  560 IF (X(9).EQ.0.) GO TO 570                                         SU3 3220
      WRITE (6,630) K,M1,REASON                                         SU3 3230
  570 IF (X(9).EQ.0.) GO TO 580                                         SU3 3240
      KIM = K*100+NMS*10+NB                                             SU3 3250
      WRITE (6,640) NSAM,KIM,NC1                                        SU3 3260
  580 IF (X(55).EQ.0.) GO TO 590                                        SU3 3270
      CALL GETIMX (K)                                                   SU3 3280
      TIM = K*0.000026                                                  SU3 3290
      WRITE (6,650) TIM                                                 SU3 3300
  590 RETURN                                                            SU3 3310
  600 WRITE (6,660)                                                     SU3 3320
      STOP                                                              SU3 3330
C                                                                       SU3 3340
  610 FORMAT (' SUBE3 IN AT',F15.8)                                     SU3 3350
  620 FORMAT (' ERROR IN SMAT OR SAMASM. CHANEL INDICATES ALL SEGMENTS.SSU3 3360
     1HIP',I3,' BATTERY',I2,' DIRECTOR',I2,' BUSY.'/(' NO AVAILABLE TIMESU3 3370
     2 RETREVABLE.'))                                                   SU3 3380
  630 FORMAT ('0','EV 3  SHIP',I3,' TARGET',I4,'  REASON',F4.0)         SU3 3390
  640 FORMAT (' EV 3  SAM',I4,' BATTERY',I6,' CHANNEL',I2)              SU3 3400
  650 FORMAT (' SUBE3 OUT AT',F15.8)                                    SU3 3410
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 660 FORMAT (' NUMBER OF SALVOS FIRED EXCEEDS 300, PROGRAM TERMINATING'
     1)
      END


      SUBROUTINE SUBE4 (IU)
C
C        THIS SUBROUTINE EVALUATES RED ASM/SSM FLIGHT PERFORMANCE
C        AND DETERMINES IF THE RED MISSILE HIT THE BLUE TARGET
C
      CCMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SM
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEE
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASO
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,Q
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4
     60),AMF,HISX(100),JACK(40,7),HISA(100)
      IQ = X(55)
      IF (IQ.EQ.0) GO TO 110
      CALL GETIMX (ID)
      PB = ID*2.6E-5
      WRITE (6,170) PB
C
C        DETERMINE THE ASM/SSM NUMBER AND TARGET SHIP NUMBER .
C
 110  ID = (IU/10)*10
      IF (ID.EQ.IU) IU = IU-1
      NAS = IFIX(FLOAT(IU)*1.0E-2+AMF)
      KP = NAS*100
      K = IU-KP
      NAM = NAS-90
      IU = IU+1
      IF (ID.EQ.IU) K = K+1
C
C        IF THE ASM/SSM HAS BEEN SHOT DOWN OR THE SHOT INVALIDATED
C        BY A BOMBER KILL, EXIT
C
      IF (ASMT(NAM,1).EQ.2..OR.ASMT(NAM,1).EQ.5.) GO TO 140
      ID = IFIX(ASMT(NAM,6)+AMF)
      PB = X(2005+(ID-1)*10)
      CALL RANDOM (ISEED,Z,1)
      X(13) = X(13)+1.
C
C        DETERMINE INFLIGHT PERFORMANCE
C
      IF (Z.LE.PB) GO TO 120
      ASMT(NAM,1) = 3.
      GC TO 140
```

```
C
C         INCREMENT THE HIT COUNTER
C
  120 IHIT(K) = IHIT(K)+1
      IF (X(5).EQ.1.) GO TO 130
      ID = IFIX(SHIP(K,4)+AMF)
      IF (IHIT(K).EQ.ID) SHIP(K,6)=0.
  130 ASMT(NAM,1) = 4.
  140 IF (X(56).EQ.0.) GO TO 150
      WRITE(6,180) NAM,K,ASMT(NAM,1),IHIT(K),ASMT(NAM,2)
  150 IF(IQ.EQ.0) GO TO 160
      CALL GETIMX (ID)
      PB = ID*2.6E-5
      WRITE (6,190) PB
  160 RETURN
C
  170 FORMAT (' SUBE4 IN AT',F15.8)
  180 FORMAT ('0','EV 4   ASM',I4,' SHIP',I3,' ASM STATUS',F3.0,' HITS O
     1N SHIP',I4,' TIME',F8.3)
  190 FORMAT (' SUBE4 OUT AT',F15.8)
      END


      SUBROUTINE SUBE5 (M)
C
C         THIS SUBROUTINE EVALUATES THE BLUE MISSILE INTERCEPT OF
C         THE RED RAIDER OR ASM/SSM
C
      CCMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SM
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEE
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASO
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,Q
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4
     60),AMF,HISX(100),JACK(40,7),HISA(100)
      IF (X(55).EQ.0.) GO TO 20
      CALL GETIMX (ID)
      PB = ID*2.6E-5
      WRITE (6,230) PB
C
C         DETERMINE THE PARTICIPANTS
C
   20 NT = IFIX(SAMASM(M,1)+AMF)
      NA = NT-90
      NMS = IFIX(SAMASM(M,2)+AMF)
      K = IFIX((SAMASM(M,2)*1.0E-1)+AMF)
      JACK(K,2) = JACK(K,2)+1
      NMS = NMS-K*10
```

```
      NB = IFIX((SAMASM(M,3)*1.0E-1)+AMF)                                SU5   260
      ID = IFIX(SHIP(K,5)+AMF)                                           SU5   270
      NC = IFIX(SAMASM(M,3)+AMF)-NB*10                                   SU5   280
      IF (NC.EQ.7) GO TO 30                                              SU5   290
C                                                                        SU5   300
C        IF THE MISSILE USES A DIRECTOR, DETERMINE THE APPROPRIATE       SU5   310
C        REASSIGNMENT DELAYS                                             SU5   320
C                                                                        SU5   330
      KEY = IFIX(X(ID+18)+AMF)                                           SU5   340
      CALL REACT (KEY,5,TF)                                              SU5   350
      IQ = IFIX(X(ID+NMS-1)+AMF)                                         SU5   360
      IP = IFIX(X(516+(IQ-1)*40+NB*2)+AMF)                               SU5   370
      KEY = IFIX(X(906+(IP-1)*20)+AMF)                                   SU5   380
      CALL REACT (KEY,4,TA)                                              SU5   390
C                                                                        SU5   400
C        INCREMENT THE FLEET AND SHIP COUNTERS IF APPROPRIATE            SU5   410
C                                                                        SU5   420
   30 IF (IGAGE(NT).NE.0) GO TO 50                                       SU5   430
      IGAGE(NT) = 1                                                      SU5   440
      IF (NT.GT.90) GO TO 40                                             SU5   450
      ISBG(K) = ISBG(K)+1                                                SU5   460
      IFBG = IFBG+1                                                      SU5   470
      GO TO 50                                                           SU5   480
   40 ISAG(K) = ISAG(K)+1                                                SU5   490
      IFAG = IFAG+1                                                      SU5   500
C                                                                        SU5   510
C        DETERMINE IF THE TARGET IS STILL THERE.                         SU5   520
C                                                                        SU5   530
   50 IF (NT.GT.90) GO TO 60                                             SU5   540
      IF (RAID(NT,13).GT.0.) GO TO 80                                    SU5   550
      GO TO 70                                                           SU5   560
   60 IF (ASMT(NA,1).EQ.2.) GO TO 70                                     SU5   570
      IF (ASMT(NA,1).NE.1.) GO TO 100                                    SU5   580
      GO TO 80                                                           SU5   590
   70 SAMASM(M,5) = -1.00                                                SU5   600
      IF (NC.EQ.7) GO TO 190                                             SU5   610
      GO TO 170                                                          SU5   620
   80 IQ = IFIX(X(ID+NMS-1)+AMF)                                         SU5   630
      PB = X(530+(IQ-1)*40)                                              SU5   640
      N = IFIX(X(524+(IQ-1)*40)+AMF)                                     SU5   650
C                                                                        SU5   660
C        DETERMINE KILL-NO KILL                                          SU5   670
C                                                                        SU5   680
      PROB = PB*(1.-(1.-SAMASM(M,7))**N)                                 SU5   690
      CALL RANDOM (ISEED,Z,1)                                            SU5   700
      X(13) = X(13)+1.                                                   SU5   710
      IF (Z.LE.PROB) GO TO 110                                           SU5   720
      IF (NC.EQ.7) GO TO 90                                              SU5   730
```

```
      CHANEL(K,NMS,NB,NC)=0.
   90 KP = NT*100000+K*1000+NMS*100+NB*10+NC
C
C        STORE A CHANNEL FREE EVENT
C
      CALL STCREV (SAMASM(M,6),3,KP)
      SAMASM(M,5) = 0.
      GO TO 220
  100 SAMASM(M,5) = 0.
      IF (NC.EQ.7) GO TO 190
      GO TO 170
  110 JACK(K,3) = JACK(K,3)+1
      IF (NT.GT.90) GO TO 150
      RAID(NT,13) = RAID(NT,13)-1.0001
      IF (RAID(NT,13).GT.0.) GO TO 160
      RAID(NT,13) = 0.0
C
C        IF A RAIDER HAS BEEN SHOT DOWN OR SJNK, AND IT WAS A JAMMER,
C        ADJUST THE JAM TABLE
C
      NDU = IFIX(RAID(NT,1)+AMF)
      IF (X(NDU+9).GT.0.) JAM(1)=JAM(1)-1
      IF (X(NDU+10).GT.0.) JAM(2)=JAM(2)-1
      IF (X(NDU+11).GT.0.) JAM(3)=JAM(3)-1
      IF (X(NDU+12).GT.0.) JAM(4)=JAM(4)-1
      RAID(NT,17) = SAMASM(M,6)
      NTOT = MISLFT(NT,1)+MISLFT(NT,2)
C
C        IF THE RAIDER HAS MISSILES LEFT ON BOARD- INDICATE "LOST
C        WHEN A/C SHOT DOWN OR SHIP SUNK"
C
      IF (NTOT.EQ.0) GO TO 130
      MISLFT(NT,1) = 0
      MISLFT(NT,2) = 0
C
      DO 120 I=1,NTOT
      NASM = NASM+1
      ASMT(NASM,1) = 5.
      ASMT(NASM,2) = 0.
      ASMT(NASM,4) = 0.
      ASMT(NASM,6) = 0.
      ASMT(NASM,7) = 0.
      ASMT(NASM,8) = 0.
      ASMT(NASM,5) = SAMASM(M,6)
      ASMT(NASM,3) = FLOAT(NT)
  120 CONTINUE
C
  130 ID = NASM-NTOT
```

```
      IF (RAID(NT,12).EQ.0.) GO TO 160                                  SU5 1220
C                                                                       SU5 1230
C        CHECK ASM LAUNCH TIME OF SHOT DOWN RAIDER OR SSM LAUNCH        SU5 1240
C        TIME OF SURFACE RAIDER- IF AFTER TARGET KILL TIME- INDICATE    SU5 1250
C        NO LAUNCH.                                                     SU5 1260
C                                                                       SU5 1270
      DO 140 I=1,ID                                                     SU5 1280
      IQ = IFIX(ASMT(I,3)+AMF)                                          SU5 1290
      IF (NT.NE.IQ) GO TO 140                                           SU5 1300
      IF (ASMT(I,5).LT.SAMASM(M,6)) GO TO 140                           SU5 1310
      ASMT(I,1) = 5.                                                    SU5 1320
      ASMT(I,2) = 0.                                                    SU5 1330
      ASMT(I,5) = SAMASM(M,6)                                           SU5 1340
      ASMT(I,4) = 0.                                                    SU5 1350
      ASMT(I,7) = 0.                                                    SU5 1360
      ASMT(I,8) = 0.                                                    SU5 1370
  140 CONTINUE                                                          SU5 1380
C                                                                       SU5 1390
      GO TO 160                                                         SU5 1400
  150 ASMT(NA,1) = 2.                                                   SU5 1410
  160 SAMASM(M,5) = FLOAT(N)                                            SU5 1420
      TK = X(533+(IQ-1)*40)                                             SU5 1430
      IF (NC.EQ.7) GO TO 190                                            SU5 1440
      SAMASM(M,6) = SAMASM(M,6)+TK+TA+TF                                SU5 1450
      JFK = NC+3                                                        SU5 1460
      SMAT(M,JFK) = SAMASM(M,6)                                         SU5 1470
      GO TO 180                                                         SU5 1480
  170 SAMASM(M,6) = SAMASM(M,6)+TA+TF                                   SU5 1490
      JFK = NC+3                                                        SU5 1500
      SMAT(M,JFK) = SAMASM(M,6)                                         SU5 1510
  180 KP = SAMASM(M,2)*100.+SAMASM(M,3)                                 SU5 1520
      CALL STOREV (SAMASM(M,6),6,KP)                                    SU5 1530
  190 IF (X(58).EQ.0.) GO TO 200                                        SU5 1540
      WRITE (6,240) M,SAMASM(M,5)                                       SU5 1550
  200 IF (X(56).EQ.0.) GO TO 210                                        SU5 1560
      WRITE (6,250) NT,K,NMS,M,SAMASM(M,6)                              SU5 1570
  210 IF (X(55).EQ.0.) GO TO 220                                        SU5 1580
      CALL GETIMX (ID)                                                  SU5 1590
      PB = ID*2.6E-5                                                    SU5 1600
      WRITE (6,260) PB                                                  SU5 1610
  220 RETURN                                                            SU5 1620
C                                                                       SU5 1630
  230 FORMAT (' SUBE5 IN AT',F15.8)                                     SU5 1640
  240 FORMAT ('0','FOR SHOT',I4,' RESULTS',F4.0)                        SU5 1650
  250 FORMAT ('0','EV 5   TGT NO.',I4,' FS',I3,' LAUNCHER',I2,' SAMS',I4SU5 1660
     1,' TIME',F8.3)                                                    SU5 1670
  260 FORMAT (' SUBE5 OUT AT',F15.8)                                    SU5 1680
      END                                                               SU5 1690
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```
      SUBROUTINE SUBE6 (M)                                              SU6   10
C                                                                       SU6   20
C          THIS SUBROUTINE RELEASES A FIRE CONTROL CHANNEL              SU6   30
C          FOR FURTHER USE AFTER AN ENGAGEMENT AND THE APPROPRIATE      SU6   40
C          TIME DELAYS.                                                 SU6   50
C                                                                       SU6   60
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMSU6   70
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEESU6   80
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOSU6   90
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QSU6  100
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),SU6  110
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4SU6  120
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             SU6  130
C                                                                       SU6  140
      IF (X(55).EQ.0.) GO TO 110                                        SU6  150
      CALL GETIMX (I)                                                   SU6  160
      T = I*2.6E-5                                                      SU6  170
      WRITE (6,130) T                                                   SU6  180
  110 M = M+2                                                           SU6  190
      K = M*1.0E-3                                                      SU6  200
      NMS = (M-K*1000)*1.0E-2                                           SU6  210
      I = M-K*1000-NMS*100                                              SU6  220
      NB = I*1.0E-1                                                     SU6  230
      NC = I-NB*10                                                      SU6  240
      NC = NC-2                                                         SU6  250
      CHANEL(K,NMS,NB,NC)=0.                                            SU6  260
      IF (X(55).EQ.0.) GO TO 120                                        SU6  270
      CALL GETIMX (I)                                                   SU6  280
      T = I*2.6E-5                                                      SU6  290
      WRITE (6,140) T                                                   SU6  300
  120 RETURN                                                            SU6  310
C                                                                       SU6  320
  130 FORMAT (' SUBE6 IN AT ',F14.8)                                    SU6  330
  140 FORMAT (' SUBE6 OUT AT',F15.8)                                    SU6  340
      END                                                               SU6  350


      SUBROUTINE TIMMY (M,K,NMS,XP,YP,PROB,FT,IND,TIME)                 TIM   10
C                                                                       TIM   20
C        TIMMY COMPUTES THE PREDICTED INTERCEPT POINT AND               TIM   30
C        DETERMINES WHETHER OR NOT IT LIES WITHIN THE INTERCEPT         TIM   40
C        CONTOUR.                                                       TIM   50
C                                                                       TIM   60
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMTIM   70
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEETIM   80
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOTIM   90
```

```
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QTIM  100
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),TIM  110
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4TIM  120
     60),AMF,HISX(100),JACK(40,7),HISA(100)                                TIM  130
      REAL *8RAT                                                          TIM  140
      FZLI = 0.                                                           TIM  150
      FZRI = 0.                                                           TIM  160
      IF (X(55).EQ.0.) GO TO 20                                           TIM  170
      CALL GETIMX (KP)                                                    TIM  180
      XT = KP*2.6E-5                                                      TIM  190
      WRITE (6,510) XT                                                    TIM  200
   20 IND = 0                                                             TIM  210
C                                                                         TIM  220
C        GET THE END OF GAME POSIT OR TARGET SHIP POSIT.                  TIM  230
C                                                                         TIM  240
      PI = 3.1415926                                                      TIM  250
      IF (M.GT.90) GO TO 30                                               TIM  260
      XT = RAID(M,5)                                                      TIM  270
      YT = RAID(M,6)                                                      TIM  280
      GO TO 40                                                            TIM  290
   30 JULIA = M-90                                                        TIM  300
      KP = IFIX(ASMT(JULIA,4)+AMF)                                        TIM  310
      XT = SHIP(KP,2)                                                     TIM  320
      YT = SHIP(KP,3)                                                     TIM  330
   40 KP = IFIX(SHIP(K,5)+AMF)                                            TIM  340
      KL = IFIX(X(KP+NMS-1)+AMF)                                          TIM  350
      KL = 501+(KL-1)*40                                                  TIM  360
C                                                                         TIM  370
C        IF FIRING SECTORS HAVE BEEN ASSIGNED TO BLUE UNITS,              TIM  380
C        DETERMINE THE SHIP'S FREE FIRE ZONES.                            TIM  390
C                                                                         TIM  400
      IF (X(8).EQ.0.) GO TO 120                                           TIM  410
      RAT = X(1204+(K-1)*5)                                               TIM  420
      RXATA(1) = RADIAN(RAT)                                              TIM  430
      RAT = X(1205+(K-1)*5)                                               TIM  440
      RXATA(3) = RADIAN(RAT)                                              TIM  450
      RAT = X(KP+19+NMS*2)                                                TIM  460
      RXATA(2) = RADIAN(RAT)                                              TIM  470
      RAT = X(KP+20+NMS*2)                                                TIM  480
      RXATA(4) = RADIAN(RAT)                                              TIM  490
C                                                                         TIM  500
      DO 50 I=1,4                                                         TIM  510
      KMART(I) = I                                                        TIM  520
   50 CONTINUE                                                            TIM  530
C                                                                         TIM  540
      CALL ZLNKA (RXATA,KMART,4)                                          TIM  550
      KP = KMART(1)*1000+KMART(2)*100+KMART(3)*10+KMART(4)                TIM  560
      IF (KP.EQ.4123.OR.KP.EQ.3124.OR.KP.EQ.4213.OR.KP.EQ.3214) GO TO 70TIM  570
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```
      IF (KP.EQ.3412.OR.KP.EQ.4312.OR.KP.EQ.3421.OR.KP.EQ.4321) GO TO 90TIM  580
      IF (KP.EQ.2341.OR.KP.EQ.2431.OR.KP.EQ.1342.OR.KP.EQ.1432) GO TO 80TIM  590
      IF (KP.EQ.1234.OR.KP.EQ.1243.OR.KP.EQ.2134.OR.KP.EQ.2143) GO TO 11TIM  600
     10                                                                 TIM  610
      IF (KP.EQ.1324.OR.KP.EQ.2413) GO TO 60                            TIM  620
      IF (KP.EQ.3241.OR.KP.EQ.4132) GO TO 100                           TIM  630
C                                                                       TIM  640
C        IF THE SHIP HAS NONE, EXIT.                                    TIM  650
C                                                                       TIM  660
      REASON = 2.                                                       TIM  670
      GO TO 480                                                         TIM  680
   60 FZL = RXATA(1)                                                    TIM  690
      FZR = RXATA(4)                                                    TIM  700
      FZL1 = RXATA(3)                                                   TIM  710
      FZR1 = RXATA(2)                                                   TIM  720
      KP = 2                                                            TIM  730
      GO TO 120                                                         TIM  740
   70 FZL = RXATA(2)                                                    TIM  750
      FZR = RXATA(1)                                                    TIM  760
      KP = 1                                                            TIM  770
      GO TO 120                                                         TIM  780
   80 FZL = RXATA(4)                                                    TIM  790
      FZR = RXATA(3)                                                    TIM  800
      KP = 1                                                            TIM  810
      GO TO 120                                                         TIM  820
   90 FZL = RXATA(3)                                                    TIM  830
      FZR = RXATA(2)                                                    TIM  840
      KP = 1                                                            TIM  850
      GO TO 120                                                         TIM  860
  100 FZL = RXATA(4)                                                    TIM  870
      FZR = RXATA(3)                                                    TIM  880
      FZL1 = RXATA(2)                                                   TIM  890
      FZR1 = RXATA(1)                                                   TIM  900
      KP = 2                                                            TIM  910
      GO TO 120                                                         TIM  920
  110 FZL = RXATA(1)                                                    TIM  930
      FZR = RXATA(4)                                                    TIM  940
      KP = 1                                                            TIM  950
C                                                                       TIM  960
C       COLLECT TARGET ALTITUDE AND MAXIMUM SAM ALTITUDE. GET           TIM  970
C          MISSILE PARAMETERS UNLESS TARGET TOO HIGH, IN WHICH          TIM  980
C          CASE, EXIT.                                                  TIM  990
C                                                                       TIM 1000
  120 KPX = 7                                                           TIM 1010
      IF (X(KL+35).EQ.1.) KPX=0                                         TIM 1020
      IF (M.GT.90) GO TO 130                                            TIM 1030
      ALT = RAID(M,9)                                                   TIM 1040
      GO TO 140                                                         TIM 1050
```

```
  130 ID = IFIX(ASMT(JULIA,6)+AMF)
      ALT = X(2002+(ID-1)*10)
  140 IF (ALT.GT.X(77)) KPX=0
      IF (ALT.LE.X(KL+15)) GO TO 150
      REASON = 11.
      GO TO 480
  150 KPX = KL+KPX
      RMAX = X(KPX)
      SSPD = X(KPX+1)
      A = X(KPX+2)
      B = X(KPX+3)
      EX = X(KPX+4)
      SLOPE = X(KPX+5)
      SEEK = X(KPX+6)
      RMIN = X(KL+14)
C
C          DETERMINE IF THE TARGET WILL ENTER THIS SYSTEM'S ENVELOPE
C
      IF (M.LE.90) GO TO 160
      IR = IFIX(ASMT(JULIA,3)+AMF)
      VEL = X(2001+(ID-1)*10)
      PQ = RAID(IR,14)
      PS = RAID(IR,15)
      RAID(IR,14) = XT
      RAID(IR,15) = YT
      PT = RAID(IR,2)
      RAID(IR,2) = TIME
      RAID(IR,3) = XP
      RAID(IR,4) = YP
      GO TO 170
  160 RAID(M,14) = XT
      RAID(M,15) = YT
      CALL LOCTIM (M,TIME,5,XI,YI)
      KR = IFIX(X(2201+(M-1)*6)+AMF)
      VEL = X(1814+(KR-1)*20)
      IR = M
  170 CALL TMDASM (IR,0,NMS,K,VEL,RMAX,TIME,TX,XI,YI,RIP,TXL,M)
      IF (M.LE.90) GO TO 180
      RAID(IR,14) = PQ
      RAID(IR,15) = PS
      CALL LOCTIM (IR,PT,5,PS,PQ)
C
C         IF TARGET BEYOND RANGE AND OUTBOUND,EXIT.
C
  180 IF (TX.NE.9120.) GO TO 190
      REASON = 7.
      GO TO 480
C
```

```
C                                                                        TIM 1540
C          DETERMINE TARGET COURSE.                                      TIM 1550
C                                                                        TIM 1560
  190 IF (M.LE.90) GO TO 220                                             TIM 1570
      KPX = IFIX(ASMT(JULIA,4)+AMF)                                      TIM 1580
      IF (KPX.NE.K) GO TO 210                                            TIM 1590
C                                                                        TIM 1600
C          IF TARGET SHIP SAME AS FIRING SHIP, DETERMINE FLIGHT TIME     TIM 1610
C                                                                        TIM 1620
      DELTAX = XT-ASMT(JULIA,7)                                          TIM 1630
      DELTAY = YT-ASMT(JULIA,8)                                          TIM 1640
      CS = ATAN2(DELTAY,DELTAX)                                          TIM 1650
      IF (CS.LT.0.) CS = CS+2.*PI                                        TIM 1660
      THETA = CS+PI                                                      TIM 1670
      IF (THETA.GT.2.*PI) THETA=THETA-2.*PI                              TIM 1680
      IF (X(59).EQ.0.) GO TO 200                                         TIM 1690
      WRITE (6,520) M,K,CS                                               TIM 1700
  200 IF (ABS(DELTAY).LT.1.0E-4) DELTAY=0.0                              TIM 1710
      IF (ABS(DELTAX).LT.1.0E-4) DELTAX=0.0                              TIM 1720
      DLT = SQRT(DELTAX**2+DELTAY**2)                                    TIM 1730
      FT = DLT/(SSPD+VEL)                                                TIM 1740
      PK = X(KL+28)                                                      TIM 1750
      GAMMA = 0.                                                         TIM 1760
      GO TO 320                                                          TIM 1770
  210 DELTAX = XT-ASMT(JULIA,7)                                          TIM 1780
      DELTAY = YT-ASMT(JULIA,8)                                          TIM 1790
      CS = ATAN2(DELTAY,DELTAX)                                          TIM 1800
      IF (CS.LT.0.) CS = CS+2.*PI                                        TIM 1810
      GO TO 230                                                          TIM 1820
  220 RAT = X(2205+(M-1)*6)                                              TIM 1830
      CS = RADIAN(RAT)                                                   TIM 1840
C                                                                        TIM 1850
C          ALPHA:  ANGLE BETWEEN THE TARGET FLIGHT PATH                  TIM 1860
C                  AND THE LINE OF SIGHT.                                TIM 1870
C                                                                        TIM 1880
C          THETA:  THE ANGLE FROM THE FIRING SHIP TO PRESENT             TIM 1890
C                  TARGET POSITION.                                      TIM 1900
C                                                                        TIM 1910
  230 DELTAY = YP-SHIP(K,3)                                              TIM 1920
      DELTAX = XP-SHIP(K,2)                                              TIM 1930
      IF (DELTAX.EQ.0..AND.DELTAY.EQ.0.) GO TO 250                       TIM 1940
  240 THETA = ATAN2(DELTAY,DELTAX)                                       TIM 1950
      IF (THETA.LT.0.) THETA=THETA+2.*PI                                 TIM 1960
      TH1 = THETA-PI                                                     TIM 1970
      IF (TH1.LT.0.) TH1 = TH1+2.*PI                                     TIM 1980
      ALPHA = ABS(CS-TH1)                                                TIM 1990
      IF (ALPHA.GT.PI) ALPHA=ALPHA-PI                                    TIM 2000
      GSINE = SIN(ALPHA)*(VEL/SSPD)                                      TIM 2010
C
```

```
C        IF GSINE GREATER THAN ONE, INTERCEPT IS IMPOSSIBLE             TIM 2020
C                                                                       TIM 2030
      IF (ABS(GSINE).LE.1.) GO TO 280                                   TIM 2040
      REASON = 10.                                                      TIM 2050
      GO TO 480                                                         TIM 2060
  250 IF (M.LE.90) GO TO 260                                            TIM 2070
      DELTAX = ASMT(JULIA,7)-SHIP(K,2)                                  TIM 2080
      DELTAY = ASMT(JULIA,8)-SHIP(K,3)                                  TIM 2090
      GO TO 240                                                         TIM 2100
  260 CALL LOCTIM (M,0.,1,XW,YW)                                        TIM 2110
      DELTAX = XW-SHIP(K,2)                                             TIM 2120
      DELTAY = YW-SHIP(K,3)                                             TIM 2130
      GO TO 240                                                         TIM 2140
  270 IF (PHI.LT.0.) PHI = PHI+2.*PI                                    TIM 2150
  280 GAMMA = ARSIN(GSINE)                                              TIM 2160
C                                                                       TIM 2170
      BETA = PI-GAMMA-ALPHA                                             TIM 2180
      DELTA = PI-BETA                                                   TIM 2190
C                                                                       TIM 2200
      IF (ABS(DELTAX).LT.5.0E-5) DELTAX=0.0                             TIM 2210
      IF (ABS(DELTAY).LT.5.0E-5) DELTAY=0.0                             TIM 2220
      DLT = SQRT(DELTAX**2+DELTAY**2)                                   TIM 2230
      IF (X(59).EQ.0.) GO TO 290                                        TIM 2240
      WRITE (6,530)                                                     TIM 2250
      WRITE (6,540)                                                     TIM 2260
      WRITE (6,550) M,K,ALPHA,BETA,GAMMA,XP,YP,GSINE,DLT                TIM 2270
  290 P4 = PI/4.                                                        TIM 2280
      IF (DELTA.LE.P4) GO TO 300                                        TIM 2290
      PK = X(KL+36)                                                     TIM 2300
      GO TO 310                                                         TIM 2310
  300 PK = X(KL+28)                                                     TIM 2320
C                                                                       TIM 2330
C        IF TARGET NOT ASM TARGETED ON FIRING SHIP, COMPUTE FLIGHT      TIM 2340
C        TIME                                                           TIM 2350
C                                                                       TIM 2360
  310 FT = DLT*SIN(ALPHA)/(SSPD*SIN(BETA))                              TIM 2370
      IF (M.LE.90) GO TO 320                                            TIM 2380
      KPX = IFIX(SHIP(K,5)+AMF)                                         TIM 2390
      IF (X(KPX+29).EQ.0.) GO TO 320                                    TIM 2400
      TKIL = TIME+FT                                                    TIM 2410
      IF (TKIL.LT.ASMT(JULIA,2)) GO TO 320                              TIM 2420
      REASON = 8.                                                       TIM 2430
      GO TO 480                                                         TIM 2440
  320 TKIL = TIME+FT                                                    TIM 2450
C                                                                       TIM 2460
C        GET INTERCEPT POSIT                                            TIM 2470
C                                                                       TIM 2480
      IF (M.GT.90) GO TO 330                                            TIM 2490
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      CALL LOCTIM (M,TKIL,44,XI,YI)                                     TIM 2500
      GO TO 340                                                         TIM 2510
  330 CALL ASMTIM (M,TKIL,XI,YI)                                        TIM 2520
  340 IF (X(8).EQ.1.) GO TO 350                                         TIM 2530
      KPX = IFIX(SHIP(K,5)+AMF)                                         TIM 2540
      RAT = X(KPX+19+NMS*2)                                             TIM 2550
      FZL = RADIAN(RAT)                                                 TIM 2560
      RAT = X(KPX+20+NMS*2)                                             TIM 2570
      FZR = RADIAN(RAT)                                                 TIM 2580
      KP = 1                                                            TIM 2590
  350 DELTAY = YI-SHIP(K,3)                                             TIM 2600
      DELTAX = XI-SHIP(K,2)                                             TIM 2610
      IF (DELTAX.EQ.0..AND.DELTAY.EQ.0.) GO TO 370                      TIM 2620
      PHI = ATAN2(DELTAY,DELTAX)                                        TIM 2630
C                                                                       TIM 2640
C        DETERMINE FIRING BEARING AND CHECK FOR GO                      TIM 2650
C                                                                       TIM 2660
      IF (PHI.LT.0.) PHI = PHI+2.*PI                                    TIM 2670
      RXATA(1) = FZL                                                    TIM 2680
      RXATA(2) = PHI                                                    TIM 2690
      RXATA(3) = FZR                                                    TIM 2700
      KMART(1) = 1                                                      TIM 2710
      KMART(2) = 2                                                      TIM 2720
      KMART(3) = 3                                                      TIM 2730
      CALL ZLNKA (RXATA,KMART,3)                                        TIM 2740
      ID = KMART(1)*100+KMART(2)*10+KMART(3)                            TIM 2750
      IF (ID.EQ.213.OR.ID.EQ.132.OR.ID.EQ.321) GO TO 410                TIM 2760
      IF (KP.EQ.2) GO TO 400                                            TIM 2770
  360 REASON = 3.                                                       TIM 2780
      IND = -1                                                          TIM 2790
      GO TO 480                                                         TIM 2800
  370 IF (M.GT.90) GO TO 390                                            TIM 2810
      CALL LOCTIM (M,0.,1,XW,YW)                                        TIM 2820
      DX = XW-SHIP(K,2)                                                 TIM 2830
      DY = YW-SHIP(K,3)                                                 TIM 2840
  380 PHI = ATAN2(DY,DX)                                                TIM 2850
      GO TO 270                                                         TIM 2860
  390 DX = ASMT(JULIA,7)-SHIP(K,2)                                      TIM 2870
      DY = ASMT(JULIA,8)-SHIP(K,3)                                      TIM 2880
      GO TO 380                                                         TIM 2890
  400 RXATA(1) = FZL1                                                   TIM 2900
      RXATA(2) = PHI                                                    TIM 2910
      RXATA(3) = FZR1                                                   TIM 2920
      KMART(1) = 1                                                      TIM 2930
      KMART(2) = 2                                                      TIM 2940
      KMART(3) = 3                                                      TIM 2950
      CALL ZLNKA (RXATA,KMART,3)                                        TIM 2960
      ID = KMART(1)*100+KMART(2)*10+KMART(3)                            TIM 2970
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      IF (ID.EQ.123.OR.ID.EQ.231.OR.ID.EQ.312) GO TO 360                TIM 2980
C                                                                       TIM 2990
C        CAN MISSILE ENGAGE                                             TIM 3000
C                                                                       TIM 3010
  410 IF (ABS(DELTAX).LT.5.0E-5) DELTAX=0.                              TIM 3020
      IF (ABS(DELTAY).LT.5.0E-5) DELTAY=0.                              TIM 3030
      DIS = SQRT(DELTAX**2+DELTAY**2)                                   TIM 3040
      IF (DIS.GE.RMIN) GO TO 420                                        TIM 3050
      REASON = 4.                                                       TIM 3060
      IND = -1                                                          TIM 3070
      GO TO 480                                                         TIM 3080
  420 PHI1 = CS-3.*PI/2.                                                TIM 3090
      IF (PHI1.LT.0.) PHI1=PHI1+2.*PI                                   TIM 3100
      XIS = XI-SHIP(K,2)                                                TIM 3110
      YIS = YI-SHIP(K,3)                                                TIM 3120
      XIP = ABS(XIS*COS(PHI1)+YIS*SIN(PHI1))                            TIM 3130
      YIP = YIS*COS(PHI1)-XIS*SIN(PHI1)                                 TIM 3140
      Z = (XIP/A)**EX+(ABS(YIP)/B)**EX                                  TIM 3150
      IF (Z.LE.1.) GO TO 430                                            TIM 3160
      REASON = 5.                                                       TIM 3170
      IND = -1                                                          TIM 3180
      GO TO 480                                                         TIM 3190
  430 Z = YIP-SLOPE*XIP                                                 TIM 3200
      IF (Z.GE.SEEK) GO TO 440                                          TIM 3210
      REASON = 6.                                                       TIM 3220
      GO TO 480                                                         TIM 3230
  440 IF (X(76).EQ.0.) GO TO 460                                        TIM 3240
      PIZ = X(76)**2                                                    TIM 3250
C                                                                       TIM 3260
      DO 450 I=1,NS                                                     TIM 3270
      IF (I.EQ.K) GO TO 450                                             TIM 3280
      DELTAX = ABS(SHIP(I,2)-XI)                                        TIM 3290
      DELTAY = ABS(SHIP(I,3)-YI)                                        TIM 3300
      IF (DELTAX.LT.5.0E-5) DELTAX=0.0                                  TIM 3310
      IF (DELTAY.LT.5.0E-5) DELTAY=0.0                                  TIM 3320
      DIS = DELTAX**2+DELTAY**2                                         TIM 3330
      IF (DIS.GE.PIZ) GO TO 450                                         TIM 3340
      IND = 2                                                           TIM 3350
      REASON = 9.                                                       TIM 3360
      GO TO 480                                                         TIM 3370
  450 CONTINUE                                                          TIM 3380
C                                                                       TIM 3390
C        IF THE TARGET IS AN ASM WHOS TARGET IS THE FIRING SHIP,        TIM 3400
C        OR THE TARGET IS A SURFACE/SUB SURFACE UNIT, PROCEED,          TIM 3410
C        OTHERWISE ADD IN THE TARGET ALTITUDE TO MISSILE FLIGHT TIME    TIM 3420
C                                                                       TIM 3430
  460 IF (M.LE.90) GO TO 470                                            TIM 3440
      JOAN = IFIX(ASMT(JULIA,4)+AMF)                                    TIM 3450
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      IF (JOAN.EQ.K) GO TO 470                                          TIM 3460
      RUTH = ALT/6000.                                                  TIM 3470
      IF (RUTH.LT.AMF) GO TO 470                                        TIM 3480
      FT = SQRT(DIS+RUTH**2)/SSPD                                       TIM 3490
  470 IND = 1                                                           TIM 3500
      PM = X(KL+30)                                                     TIM 3510
      PROB = PK*PM                                                      TIM 3520
      IF (X(9).EQ.0.) GO TO 490                                         TIM 3530
      WRITE (6,560) M,K                                                 TIM 3540
      WRITE (6,570) SHIP(K,2),SHIP(K,3),XI,YI,KP,FZL,FZR,FZL1,FZR1,PHI  TIM 3550
  480 IF (X(9).EQ.0.) GO TO 490                                         TIM 3560
      WRITE (6,580) M,K,IND,REASON                                      TIM 3570
  490 IF (X(55).EQ.0.) GO TO 500                                        TIM 3580
      CALL GETIMX (KP)                                                  TIM 3590
      XT = KP*2.6E-5                                                    TIM 3600
      WRITE (6,590) XT                                                  TIM 3610
  500 RETURN                                                            TIM 3620
C                                                                       TIM 3630
  510 FORMAT (' TIMMY IN AT',F15.8)                                     TIM 3640
  520 FORMAT ('0','    TARGET',I4,'     SHIP',I3,'   TARGET COURSE',F5.2)TIM 3650
  530 FORMAT ('0','CROSSING TARGET DATA')                               TIM 3660
  540 FORMAT ('0','TARGET  SAM SHIP  ANGLE BETWEEN   ANGLE BETWEEN    ANTIM 3670
     1GLE BETWEEN',6X,'XP',7X,'YP    GSINE  RANGE TO'/(19X,'TGT PATH & LTIM 3680
     2OS  SAM FLIGHT PATH   SAM FLIGHT PATH',27X,'TARGET'/(19X,'AT LAUNCTIM 3690
     3H TIME  TGT FLIGHT PATH  LOS AT LAUNCH')))                        TIM 3700
  550 FORMAT ('0',I4,I7,F13.4,F15.4,F17.4,F13.2,F9.2,F8.4,F9.2)         TIM 3710
  560 FORMAT ('0','INTERCEPT DATA... TGT',I4,'  FIRING SHIP',I3)        TIM 3720
  570 FORMAT ('0',' X-FS',7X,'Y-FS',7X,'X-INT',6X,'Y-INT',2X,'# ZONES',3TIM 3730
     1X,'LEFT 1. RIGHT 1',5X,'LEFT 2  RIGHT 2',5X,'SAM TRAJ. BEARING'/(FTIM 3740
     27.2,2(5X,F6.2),4X,F6.2,4X,I4,2(3X,F6.3),5X,F6.3,3X,F6.3,10X,F6.3))TIM 3750
  580 FORMAT ('0','TGT',I4,' SHIP',I3,' IND IS',I3,' REASON IS',F3.0)   TIM 3760
  590 FORMAT (' TIMMY OUT AT',F15.8)                                    TIM 3770
      END                                                               TIM 3780


      SUBROUTINE JAMM (RG,I,IR,IJ,ID,VEL,RRH,AREA,IBM,ICPA,RGI)         JAM   10
C          THIS SUBROUTINE DETERMINES THE RANGE AT WHICH A TARGET CAN   JAM   20
C          BE DETECTED IN A MULTIPLE STAND-OFF JAMMING ENVIRONMENT      JAM   30
C          RG---------MINIMUM OF CLEAR AND HORIZON RANGES (INPUT)       JAM   40
C          I----------SHIP NUMBER OF RADAR PLATFORM (INPUT)             JAM   50
C          IR---------RAIDER NUMBER OF TARGET (INPUT)                   JAM   60
C          IJ---------FREQUENCY BAND OF RADAR (INPUT)                   JAM   70
C          ID---------RADAR CLASS NUMBER (INPUT)                        JAM   80
C          VEL--------VELOCITY OF RAIDER IN NM/MIN (INPUT)              JAM   90
C          RRH--------RADAR'S HORIZON (INPUT)                           JAM  100
C          AREA-------FOURTH ROOT OF RAIDER'S RADAR CROSS SECTION (INPUT) JAM  110
C          IBM--------FLAG INDICATING IF TARGET IS AN AIRCRAFT OR MISSILE.JAM  120
C                     EQUAL TO 0 IF TARGET IS A BOMBER.   IF TARGET IS A  JAM  130
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C                   MISSILE SET TO 1 (INPUT)                            JAM  140
C         ICPA------FLAG INDICATING IF TARGET'S CPA LESS THAN DETECTION JAM  150
C                   RANGE. EQUAL TO 0 IF CPA IS BEYOND RANGE (OUTPUT)   JAM  160
C         RGI-------DETECTION RANGE (OUTPUT)                            JAM  170
C                                                                       JAM  180
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMJAM  190
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEEJAM  200
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOJAM  210
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QJAM  220
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),JAM  230
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4JAM  240
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             JAM  250
      REAL *4JJTBR,LJBW,JRBRG,LTBRG                                     JAM  260
      IF (X(55).EQ.0.) GO TO 20                                         JAM  270
      CALL GETIMX (IET)                                                 JAM  280
      T = IET*.0000026                                                  JAM  290
      WRITE (6,290) T                                                   JAM  300
   20 ICPA = 1                                                          JAM  310
C                                                                       JAM  320
C         SET SITE VALUES                                               JAM  330
C                                                                       JAM  340
      XR = SHIP(I,2)                                                    JAM  350
      YR = SHIP(I,3)                                                    JAM  360
C                                                                       JAM  370
C         SET TRACK VALUES                                              JAM  380
C                                                                       JAM  390
      IF (IBM.EQ.0) GO TO 30                                            JAM  400
      X1 = ASMT(NASM,7)                                                 JAM  410
      Y1 = ASMT(NASM,8)                                                 JAM  420
      ITS = IFIX(ASMT(NASM,4)+AMF)                                      JAM  430
      XO = SHIP(ITS,2)                                                  JAM  440
      YO = SHIP(ITS,3)                                                  JAM  450
      MIC = IFIX(ASMT(NASM,6)+AMF)                                      JAM  460
      Z1 = X(2002+(MIC-1)*10)/6000.                                     JAM  470
      TIMC = ASMT(NASM,5)                                               JAM  480
      GO TO 40                                                          JAM  490
   30 X1 = RAID(IR,3)                                                   JAM  500
      Y1 = RAID(IR,4)                                                   JAM  510
      XO = RAID(IR,14)                                                  JAM  520
      YO = RAID(IR,15)                                                  JAM  530
      Z1 = RAID(IR,9)/6000.                                             JAM  540
      TIMC = RAID(IR,2)                                                 JAM  550
   40 CALL CPA (X1,Y1,XO,YO,XR,YR,XC,YC)                                JAM  560
      RCPS = (XR-XC)**2+(YR-YC)**2+Z1**2                                JAM  570
      RGS = RG**2                                                       JAM  580
C                                                                       JAM  590
C         DETERMINE IF CPA IS WITHIN RANGE                              JAM  600
C                                                                       JAM  610
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      IF (RCPS.GE.RGS) GO TO 250                                          JAM  620
      DELX = ABS(XO-X1)-0.1                                               JAM  630
      DELY = ABS(YO-Y1)-0.1                                               JAM  640
      IF (DELX.LT.0.0.AND.DELY.LT.0.0) GO TO 90                           JAM  650
      IF (DELX) 50,60,60                                                  JAM  660
   50 TIMI = (ABS(YC-Y1))/VEL+TIMC                                        JAM  670
      GO TO 100                                                           JAM  680
   60 IF (DELY) 70,80,80                                                  JAM  690
   70 TIMI = (ABS(XC-X1))/VEL+TIMC                                        JAM  700
      GO TO 100                                                           JAM  710
   80 VD = SQRT((XO-X1)**2+(YO-Y1)**2)                                    JAM  720
      VX = VEL*(XO-X1)/VD                                                 JAM  730
      VY = VEL*(YO-Y1)/VD                                                 JAM  740
      TIMX = (XC-X1)/VX                                                   JAM  750
      TIMY = (YC-Y1)/VY                                                   JAM  760
      TIMI = (TIMX+TIMY)/2.+TIMC                                          JAM  770
      GO TO 100                                                           JAM  780
   90 TIMI = 3.0                                                          JAM  790
C                                                                         JAM  800
C          DETERMINE BEARING FROM RADAR TO TARGET IN RADIANS              JAM  810
C                                                                         JAM  820
  100 YRT = YC-YR                                                         JAM  830
      XRT = XC-XR                                                         JAM  840
      IF (YRT.NE.0.0.OR.XRT.NE.0.0) GO TO 110                             JAM  850
      YRT = Y1-YR                                                         JAM  860
      XRT = X1-XR                                                         JAM  870
  110 TBRG = ATAN2(YRT,XRT)                                               JAM  880
      IF (TBRG.LT.0.) TBRG=TBRG+6.2831853                                 JAM  890
C                                                                         JAM  900
C          GET HALF RADAR BEAM WIDTH IN RADIANS                           JAM  910
C                                                                         JAM  920
      HRBW = X(911+(ID-1)*20)                                             JAM  930
      SUMJP = 0.0                                                         JAM  940
      RCOF = X(904+(ID-1)*20)                                             JAM  950
C                                                                         JAM  960
C          DETERMINE JAMMING LEVEL AT THE RADAR IN DIRECTION OF TARGET    JAM  970
C                                                                         JAM  980
      DO 240 N=1,NR                                                       JAM  990
      IF (TIMI.GT.RAID(N,17)) GO TO 240                                   JAM 1000
      RCOFF = RCOF                                                        JAM 1010
      IRC = IFIX(X(2201+(N-1)*6)+AMF)                                     JAM 1020
      IIR = (IRC-1)*20                                                    JAM 1030
C                                                                         JAM 1040
C          FIND JAMMING POWER OF RAIDER ON RADAR BAND                     JAM 1050
C                                                                         JAM 1060
      PJ = X(1809+IIR+IJ)                                                 JAM 1070
      IF (PJ.LE.0.0) GO TO 240                                            JAM 1080
      CALL LOCTIM (N,TIMI,1,XJ,YJ)                                        JAM 1090
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C                                                                       JAM 1100
C         DETERMINE IF JAMMER IS ABOVE RADAR HORIZON                    JAM 1110
C                                                                       JAM 1120
      RJHS = (RAID(N,10)+RRH)**2                                        JAM 1130
      RRJS = (XR-XJ)**2+(YR-YJ)**2                                      JAM 1140
      IF (RRJS.GT.RJHS) GO TO 240                                       JAM 1150
C                                                                       JAM 1160
C         DETERMINE COORDINATES OF JAMMER TARGET                        JAM 1170
C                                                                       JAM 1180
      JS = IFIX(X(2206+(N-1)*6)+AMF)                                    JAM 1190
      IF (JS.EQ.0) GO TO 240                                            JAM 1200
      IF (JS.GT.40) GO TO 120                                           JAM 1210
      XJT = SHIP(JS,2)                                                  JAM 1220
      YJT = SHIP(JS,3)                                                  JAM 1230
      GO TO 130                                                         JAM 1240
  120 XJT = 0.0                                                         JAM 1250
      YJT = 0.0                                                         JAM 1260
  130 YJR = YR-YJ                                                       JAM 1270
      XJR = XR-XJ                                                       JAM 1280
      IF (YJR.NE.0.0.OR.XJR.NE.0.0) GO TO 140                           JAM 1290
      CALL LOCTIM (N,0.0,1,XJJ,YJJ)                                     JAM 1300
      YJR = YR-YJJ                                                      JAM 1310
      XJR = XR-XJJ                                                      JAM 1320
C                                                                       JAM 1330
C         GET BEARING FROM JAMMER TO RADAR AND FROM RADAR TO JAMMER     JAM 1340
C                                                                       JAM 1350
  140 JRBRG = ATAN2(YJR,XJR)                                            JAM 1360
      IF (JRBRG.LT.0.0) JRBRG=JRBRG+6.2831853                           JAM 1370
      RJBRG = JRBRG-3.1415926                                           JAM 1380
      IF (RJBRG.LT.0.0) RJBRG=RJBRG+6.2831853                           JAM 1390
C                                                                       JAM 1400
C         FIND BEARING FROM JAMMER TO JAMMER'S TARGET                   JAM 1410
C                                                                       JAM 1420
      YJJT = YJT-YJ                                                     JAM 1430
      XJJT = XJT-XJ                                                     JAM 1440
      IF (YJJT.NE.0.0.OR.XJJT.NE.0.0) GO TO 150                         JAM 1450
      CALL LOCTIM (N,0.0,1,XJJ,YJJ)                                     JAM 1460
      YJJT = YJT-YJJ                                                    JAM 1470
      XJJT = XJT-XJJ                                                    JAM 1480
  150 JJTBR = ATAN2(YJJT,XJJT)                                          JAM 1490
      IF (JJTBR.LT.0.0) JJTBR=JJTBR+6.2831853                           JAM 1500
C                                                                       JAM 1510
C         GET JAMMER SIDE-LOBE COEFFICIENT AND HALF-BEAM WIDTH          JAM 1520
C                                                                       JAM 1530
      COFF = X(1818+IIR)                                                JAM 1540
      HJBW = X(1817+IIR)                                                JAM 1550
      LJBW = JJTBR+HJBW                                                 JAM 1560
      RJBW = JJTBR-HJBW                                                 JAM 1570
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C
C         DETERMINE IF RADAR IS IN MAIN BEAM OF JAMMER
C
      IF (LJBW.GT.6.2831853) GO TO 160
      IF (RJBW.LT.0.0) GO TO 170
      IF (LJBW.GT.JRBRG.AND.RJBW.LT.JRBRG) COFF=1.0
      GO TO 190
  160 LJBW = LJBW-6.2831853
      GO TO 180
  170 RJBW = RJBW+6.2831853
  180 IF (LJBW.GT.JRBRG.OR.RJBW.LT.JRBRG) COFF=1.0
C
C         DETERMINE IF JAMMER IS IN MAIN BEAM OF RADAR
C
  190 LTBRG = TBRG+HRBW
      RTBRG = TBRG-HRBW
      IF (LTBRG.GT.6.2831853) GO TO 200
      IF (RTBRG.LT.0.0) GO TO 210
      IF (LTBRG.GT.RJBRG.AND.RTBRG.LT.RJBRG) RCOFF=1.0
      GO TO 230
  200 LTBRG = LTBRG-6.2831853
      GO TO 220
  210 RTBRG = RTBRG+6.2831853
  220 IF (LTBRG.GT.RJBRG.OR.RTBRG.LT.RJBRG) RCOFF=1.0
  230 XCOF = COFF*RCOFF
      RRJS = (RRJS+(RAID(N,9)/6000.)**2)
      SUMJP = SUMJP+(XCOF*PJ/RRJS)
  240 CONTINUE
C
      IF (SUMJP.LE.0.0) GO TO 260
      RGI = AREA*SQRT(X(903+(ID-1)*20))/SUMJP**.25
      RGI = AMIN1(RG,RGI)
      IF (RGI**2.LE.RCPS) GO TO 250
      GO TO 270
  250 ICPA = 0
      RGI = 0.0
      GO TO 270
  260 RGI = RG
  270 IF (X(55).EQ.0.) GO TO 280
      CALL GETIMX (IET)
      T = IET*.0000026
      WRITE (6,300) T
  280 RETURN
C
  290 FORMAT ('  JAMM IN AT ',F15.8)
  300 FORMAT ('  JAMM OUT AT',F15.8)
      END
```

```
      SUBROUTINE BIDET (N,NSR,ALT,IR,VEL,SIGMA,ND,TD,TL,RR,TD2,TL2,R2,IB
     1M)
C           THIS SUBROUTINE DETERMINES WHEN A TARGET IS DETECTED BY A
C           BISTATIC RADAR SYSTEM IN EITHER A CLEAR OR A JAMMING SITUATION
C           N----------RADAR RECEIVER SHIP NUMBER (INPUT)
C           NSR--------SEARCH RADAR NUMBER (INPUT)
C           ALT--------TARGET ALTITUDE IN FEET (INPUT)
C           IR---------RAIDER NUMBER OF TARGET (INPUT)
C           SIGMA------TARGET CRUSS SECTION IN METERS SQUARED (INPUT)
C           ND---------NUMBER OF DETECTION ZONES. 0--TARGET NOT DETECTED
C                      1--ONE DETECTION ZONE, 2--TWO ZONES (OUTPUT)
C           TD---------TIME OF FIRST DETECTION (OUTPUT)
C           TL---------TIME CONTACT LOST IN FIRST DETECTION ZONE (OUTPUT)
C           RR---------RANGE FROM RECEIVER TO TARGET AT TIME OF DETECTION
C                      IN FIRST ZONE (OUTPUT)
C           TD2--------TIME OF INITIAL DETECTION IN SECOND ZONE. USED ONLY
C                      IF ND=2  (OUTPUT)
C           TL2--------IF ND=2, TIME CONTACT LOST IN SECOND ZONE (OUTPUT)
C           R2---------IF ND=2, RANGE AT WHICH TARGET FIRST DETECTED IN
C                      SECOND DETECTION ZONE (OUTPUT)
C           IBM--------FLAG INDICATING IF TARGET IS AN AIRCRAFT OR MISSILE.
C                      SET TO 0 FOR BOMBER, 1 FOR MISSILE (INPUT).
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SM
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEE
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASO
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,Q
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4
     60),AMF,HISX(100),JACK(40,7),HISA(100)
      REAL *4JJTBR,LJBW,JRBRG,LTBRG
      DIMENSION XCOF(5), COF(5), TIME(4), TIMEI(4), T(4)
      REAL *8VD,VX,VY,A,B,C,E,F,XCOF,TIME,SUMJP,XCOFF
      REAL *8CHAR,RRAD,COF,TIMEI,A2,CC,EE,XRAD,A1,CHAS
      IF (X(55).EQ.0.) GO TO 20
      CALL GETIMX (IET)
      PIGS = IET*.000026
      WRITE (6,530) PIGS
C
C    SET SITE VALUES
C
   20 XR = SHIP(N,2)
      YR = SHIP(N,3)
      L = IFIX(SHIP(N,5)+AMF)
C
C    BISTATIC RECEIVER HEIGHT IN FEET
C
      ZR = X(L+6+NSR)
```

```
      ZRN = ZR/6000.                                                    BID  480
      LL = IFIX(X(L+3+NSR)+AMF)                                         BID  490
      LLJ = (LL-1)*20                                                   BID  500
      CHAS = DBLE(X(902+LLJ))                                           BID  510
      CHAR = DBLE(SIGMA)*CHAS**4                                        BID  520
      IT = IFIX(X(917+LLJ)+AMF)                                         BID  530
      XX = SHIP(IT,2)                                                   BID  540
      YX = SHIP(IT,3)                                                   BID  550
C                                                                       BID  560
C   BISTATIC TRANSMITTER HEIGHT IN FEET                                 BID  570
C                                                                       BID  580
      ZX = X(918+LLJ)                                                   BID  590
      ZXN = ZX/6000.                                                    BID  600
C                                                                       BID  610
C   SET TRACK VALUES                                                    BID  620
C                                                                       BID  630
      X1 = RAID(IR,3)                                                   BID  640
      Y1 = RAID(IR,4)                                                   BID  650
      XO = RAID(IR,14)                                                  BID  660
      YO = RAID(IR,15)                                                  BID  670
      Z1 = ALT/6000.0                                                   BID  680
      Z12 = (ALT/6000.0)**2                                             BID  690
      V = VEL                                                           BID  700
      TIMC = RAID(IR,2)                                                 BID  710
      IFLAG = 0                                                         BID  720
      JFLAG = 0                                                         BID  730
C                                                                       BID  740
C           CHECK FOR TARGET CPA AT RECEIVER OR TRANSMITTER LOCATION    BID  750
C                                                                       BID  760
      DELX = ABS(XO-XR)-0.01                                            BID  770
      DELY = ABS(YO-YR)-0.01                                            BID  780
      IF (DELX.LT.0.0.AND.DELY.LT.0.0) GO TO 70                         BID  790
      DELX = ABS(XO-XX)-0.01                                            BID  800
      DELY = ABS(YO-YX)-0.01                                            BID  810
      IF (DELX.LT.0.0.AND.DELY.LT.0.0) GO TO 80                         BID  820
C                                                                       BID  830
C    DETERMINE IF NO MOTION IN X AND Y DIRECTIONS                       BID  840
C                                                                       BID  850
      DELY = ABS(Y1-YO)-0.1                                             BID  860
      DELX = ABS(X1-XO)-0.1                                             BID  870
      IF (DELX.LT.0.0.AND.DELY.LT.0.0) GO TO 40                         BID  880
C                                                                       BID  890
C   COMPUTE CPA TO RECEIVER AND TRANSMITTER                             BID  900
C                                                                       BID  910
      IF (DELY) 30,50,50                                                BID  920
   30 XRC = XR                                                          BID  930
      YRC = Y1                                                          BID  940
      XXC = XX                                                          BID  950
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      YXC = Y1                                                          BID  960
      GO TO 100                                                         BID  970
   40 IFLAG = 1                                                         BID  980
      GO TO 100                                                         BID  990
   50 IF (DELX) 60,90,90                                                BID 1000
   60 XRC = X1                                                          BID 1010
      YRC = YR                                                          BID 1020
      XXC = X1                                                          BID 1030
      YXC = YX                                                          BID 1040
      GO TO 100                                                         BID 1050
   70 XRC = XO                                                          BID 1060
      YRC = YO                                                          BID 1070
      CALL CPA (X1,Y1,XO,YO,XX,YX,XXC,YXC)                              BID 1080
      GO TO 100                                                         BID 1090
   80 XXC = XO                                                          BID 1100
      YXC = YO                                                          BID 1110
      CALL CPA (X1,Y1,XO,YO,XR,YR,XRC,YRC)                              BID 1120
      GO TO 100                                                         BID 1130
   90 Q = (Y1-YO)/(X1-XO)                                               BID 1140
      XRC = (YR-YO+XR/Q+Q*XO)/(Q+1/Q)                                   BID 1150
      YRC = YR-(XRC-XR)/Q                                               BID 1160
      XXC = (YX-YO+XX/Q+Q*XO)/(Q+1/Q)                                   BID 1170
      YXC = YX-(XXC-XX)/Q                                               BID 1180
C                                                                       BID 1190
C      DETERMINE TIME OF DETECTION                                      BID 1200
C   COMPUTE RADAR HORIZON FOR TRANS AND RECEIVER                        BID 1210
C                                                                       BID 1220
  100 HORRS = (X(81)**2)*(SQRT(ALT)+SQRT(ZR))**2                        BID 1230
      HORXS = (X(81)**2)*(SQRT(ALT)+SQRT(ZX))**2                        BID 1240
      IF (IFLAG.EQ.1) GO TO 200                                         BID 1250
      CPRS = (XR-XRC)**2+(YR-YRC)**2+(ZRN-Z1)**2                        BID 1260
      CPXS = (XX-XXC)**2+(YX-YXC)**2+(ZXN-Z1)**2                        BID 1270
C                                                                       BID 1280
C    IF CPA TO RCVR OR TRANS BEYOND RESPECTIVE RADAR HORIZON NO DET     BID 1290
C                                                                       BID 1300
      IF (CPRS.GE.HORRS.OR.CPXS.GE.HORXS) GO TO 220                     BID 1310
      VD = DBLE(SQRT((X1-XO)**2+(Y1-YO)**2))                            BID 1320
      VX = V*(XO-X1)/VD                                                 BID 1330
      VY = V*(YO-Y1)/VD                                                 BID 1340
      A = VX**2+VY**2                                                   BID 1350
      A2 = A**2                                                         BID 1360
      B = -2*(VX*(XRC-X1)+VY*(YRC-Y1))                                  BID 1370
      C = CPRS+(XRC-X1)**2+(YRC-Y1)**2                                  BID 1380
      D = -2*(VX*(XXC-X1)+VY*(YXC-Y1))                                  BID 1390
      E = CPXS+(XXC-X1)**2+(YXC-Y1)**2                                  BID 1400
C                                                                       BID 1410
C    DETERMINE TIME TARGET ABOVE BI-STATIC RADAR HORIZON(T10,T20)       BID 1420
C                                                                       BID 1430
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      A1 = 2*A                                                          BID 1440
      CC = C-HORRS                                                      BID 1450
      RRAD = DSQRT(B**2-4*A*CC)                                         BID 1460
      TR1 = (-B-RRAD)/A1                                                BID 1470
      TR2 = (-B+RRAD)/A1                                                BID 1480
      EE = E-HORXS                                                      BID 1490
      XRAD = DSQRT(D**2-4*A*EE)                                         BID 1500
      TX1 = (-D-XRAD)/A1                                                BID 1510
C                                                                       BID 1520
C   T10 IS TIME FIRST ABOVE BI-STATIC RADAR HORIZON, T20 TIME DOWN      BID 1530
C                                                                       BID 1540
      T10 = AMAX1(TR1,TX1)                                              BID 1550
      T20 = AMIN1(TR2,TX2)                                              BID 1560
      T10 = T10+TIMC                                                    BID 1570
      T20 = T20+TIMC                                                    BID 1580
C                                                                       BID 1590
C   DETERMINE IF TRANS/RCVR RADAR HORIZONS OVERLAP ALONG TRACK AND      BID 1600
C    AFTER START OF GAME AND BEFORE END OF GAME                         BID 1610
C                                                                       BID 1620
      IF (T10.GE.T20.OR.T20.LE.0.0.OR.T10.GE.X(82)) GO TO 220           BID 1630
      XCOF(5) = 0.1D01                                                  BID 1640
      XCOF(4) = (B+D)/A                                                 BID 1650
      XCOF(3) = ((C+E)/A)+(B*D/A2)                                      BID 1660
      XCOF(2) = ((B*E)+(C*D))/A2                                        BID 1670
  110 XCOF(1) = (C*E-CHAR)/A2                                           BID 1680
      CALL DTIMD (XCOF,COF,4,TIME,TIMEI,IER)                            BID 1690
      IF (IER.NE.0) GO TO 220                                           BID 1700
C                                                                       BID 1710
C   CHECK FOR REAL ROOTS, IE, TIMEI=0 IF ROOT IS REAL                   BID 1720
C                                                                       BID 1730
      IF (TIMEI(1).NE.0.0D0.AND.TIMEI(2).NE.0.0D0.AND.TIMEI(3).NE.0.0D0.BID 1740
     1AND.TIMEI(4).NE.0.0D0) GO TO 220                                  BID 1750
      KRR = 1                                                           BID 1760
C                                                                       BID 1770
      DO 120 NNN=1,4                                                    BID 1780
      IF (TIMEI(NNN).NE.0.0D0) GO TO 120                                BID 1790
      T(KRR) = TIME(NNN)+TIMC                                           BID 1800
      KRR = KRR+1                                                       BID 1810
  120 CONTINUE                                                          BID 1820
C                                                                       BID 1830
C   CHECK FOR TWO OVALS OF CASSINI; IF TWO COMPUTE 2ND DET FIRST        BID 1840
C                                                                       BID 1850
      IF (KRR.EQ.5) GO TO 160                                           BID 1860
      IF (T(1).LT.T(2)) GO TO 130                                       BID 1870
      T1 = T(2)                                                         BID 1380
      T2 = T(1)                                                         BID 1890
      GO TO 140                                                         BID 1900
  130 T1 = T(1)                                                         BID 1910
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      T2 = T(2)                                                         BID 1920
C                                                                       BID 1930
C    CHECK FOR LOSS OF TARGET PRIOR TO START OF GAME                    BID 1940
C                                                                       BID 1950
  140 IF (T2.LE.0.0.OR.T1.EQ.T2) GO TO 220                              BID 1960
  150 IF (T1.LT.0.0) T1 = 0.0                                           BID 1970
C                                                                       BID 1980
C    CHECK TO SEE IF TARGET WAS DETECTED PRIOR TO START OF GAME         BID 1990
C                                                                       BID 2000
      IF (T2.LE.T10.OR.T20.LE.T1) GO TO 220                             BID 2010
C                                                                       BID 2020
C    ONE DETECTION ZONE                                                 BID 2030
C                                                                       BID 2040
      TD = AMAX1(T1,T10)                                                BID 2050
      TL = AMIN1(T2,T20)                                                BID 2060
      ND = 1                                                            BID 2070
C                                                                       BID 2080
C    COMPUTE DETECTIONS TWO OVALS                                       BID 2090
C                                                                       BID 2100
      GO TO 230                                                         BID 2110
C                                                                       BID 2120
  160 DO 170 II=1,4                                                     BID 2130
  170 T(II) = TIME(II)                                                  BID 2140
C                                                                       BID 2150
      IF (T(1).LT.T(2).AND.T(2).LT.T(3).AND.T(3).LT.T(4)) GO TO 180     BID 2160
      CALL TJSORT (T,4)                                                 BID 2170
  180 IF (T(4).LE.0.0) GO TO 220                                        BID 2180
      IF (T(2).LE.T10.AND.T(3).GE.T20) GO TO 220                        BID 2190
      IF (T(4).LE.T10.OR.T(1).GE.T20) GO TO 220                         BID 2200
      IF (T(2).LE.0.0.OR.T(2).LE.T10) GO TO 190                         BID 2210
      IF (T(3).GE.T20) GO TO 130                                        BID 2220
      IF (T(1).LE.0.0) T(1)=0.0                                         BID 2230
      TD = AMAX1(T(1),T10)                                              BID 2240
      TL = T(2)                                                         BID 2250
      TD2 = T(3)                                                        BID 2260
      TL2 = AMIN1(T(4),T20)                                             BID 2270
      ND = 2                                                            BID 2280
      GO TO 230                                                         BID 2290
  190 T1 = T(3)                                                         BID 2300
      T2 = T(4)                                                         BID 2310
      GO TO 150                                                         BID 2320
C                                                                       BID 2330
C    DETERMINE IF NON-MOVING TARGET IS DETECTED                         BID 2340
C                                                                       BID 2350
  200 RD2 = (X1-XR)**2+(Y1-YR)**2+Z12                                   BID 2360
      XD2 = (X1-XX)**2+(Y1-YX)**2+Z12                                   BID 2370
      IF (RD2.GT.HORRS.OR.XD2.GT.HORXS) GO TO 220                       BID 2380
  210 IF (RD2*XD2-CHAR.GT.0.0D0) GO TO 220                              BID 2390
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      TD = 0.0                                                          BID 2400
      TL = X(82)                                                        BID 2410
      ND = 1                                                            BID 2420
      GO TO 230                                                         BID 2430
  220 ND = 0                                                            BID 2440
      GO TO 510                                                         BID 2450
  230 IF (JFLAG.EQ.1) GO TO 400                                         BID 2460
      NJ = IFIX(X(17)+AMF)                                              BID 2470
      IF (NJ.EQ.0) GO TO 400                                            BID 2480
      IJ = IFIX(X(907+LLJ)+AMF)                                         BID 2490
      IF (JAM(IJ).EQ.0) GO TO 400                                       BID 2500
      IF (IFLAG.EQ.1) GO TO 240                                         BID 2510
      TIMI = (TD+TL)/2.                                                 BID 2520
      GO TO 250                                                         BID 2530
  240 TIMI = 3.0                                                        BID 2540
C                                                                       BID 2550
C          DETERMINE BEARING FROM RADAR TO TARGET IN RADIANS            BID 2560
C                                                                       BID 2570
  250 YRT = Y1+VY*(TIMI-TIMC)-YR                                        BID 2580
      XRT = X1+VX*(TIMI-TIMC)-XR                                        BID 2590
      IF (YRT.NE.0.0.OR.XRT.NE.0.0) GO TO 260                           BID 2600
      YRT = Y1-YR                                                       BID 2610
      XRT = X1-XR                                                       BID 2620
  260 TBRG = ATAN2(YRT,XRT)                                             BID 2630
      IF (TBRG.LT.0.) TBRG=TBRG+6.2831853                               BID 2640
C                                                                       BID 2650
C          GET HALF RADAR BEAM WIDTH IN RADIANS                         BID 2660
C                                                                       BID 2670
      HRBW = X(911+LLJ)                                                 BID 2680
      RCOF = X(904+LLJ)                                                 BID 2690
      RRH = X(81)*SQRT(ZR)                                              BID 2700
      SUMJP = 0.0D0                                                     BID 2710
C                                                                       BID 2720
C          DETERMINE JAMMING LEVEL AT THE RADAR IN DIRECTION OF TARGET  BID 2730
C                                                                       BID 2740
      DO 390 L=1,NR                                                     BID 2750
      IF (TIMI.GT.RAID(L,17)) GO TO 390                                 BID 2760
      RCOFF = RCOF                                                      BID 2770
      IIR = IFIX(RAID(L,1)+AMF)                                         BID 2780
C                                                                       BID 2790
C          FIND JAMMING POWER OF RAIDER ON RADAR BAND                   BID 2800
C                                                                       BID 2810
      PJ = X(IIR+8+IJ)                                                  BID 2820
      IF (PJ.LE.0.0) GO TO 390                                          BID 2830
      CALL LOCTIM (L,TIMI,1,XJ,YJ)                                      BID 2840
C                                                                       BID 2850
C          DETERMINE IF JAMMER IS ABOVE RADAR HORIZON                   BID 2860
C                                                                       BID 2870
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```
      RJHS = (RAID(L,10)+RRH)**2
      RRJS = (XR-XJ)**2+(YR-YJ)**2
      IF (RRJS.GT.RJHS) GO TO 390
C
C          DETERMINE COORDINATES OF JAMMER TARGET
C
      JS = IFIX(X(2206+(L-1)*6)+AMF)
      IF (JS.EQ.0) GO TO 390
      IF (JS.GT.40) GO TO 270
      XJT = SHIP(JS,2)
      YJT = SHIP(JS,3)
      GO TO 280
  270 XJT = 0.0
      YJT = 0.0
  280 YJR = YR-YJ
      XJR = XR-XJ
      IF (YJR.NE.0.0.OR.XJR.NE.0.0) GO TO 290
      CALL LOCTIM (L,0.0,1,XJJ,YJJ)
      YJR = YR-YJJ
      XJR = XR-XJJ
C
C          GET BEARING FROM JAMMER TO RADAR AND FROM RADAR TO JAMMER
C
  290 JRBRG = ATAN2(YJR,XJR)
      IF (JRBRG.LT.0.0) JRBRG=JRBRG+6.2831853
      RJBRG = JRBRG-3.1415926
      IF (RJBRG.LT.0.0) RJBRG=RJBRG+6.2831853
C
C          FIND BEARING FROM JAMMER TO JAMMER'S TARGET
C
      YJJT = YJT-YJ
      XJJT = XJT-XJ
      IF (YJJT.NE.0.0.OR.XJJT.NE.0.0) GO TO 300
      CALL LOCTIM (L,0.0,1,XJJ,YJJ)
      YJJT = YJT-YJJ
      XJJT = XJT-XJJ
  300 JJTBR = ATAN2(YJJT,XJJT)
      IF (JJTBR.LT.0.0) JJTBR=JJTBR+6.2831853
C
C          GET JAMMER SIDE-LOBE COEFFICIENT AND HALF-BEAM WIDTH
C
      HJBW = X(IIR+16)
      COFF = X(IIR+17)
      LJBW = JJTBR+HJBW
      RJBW = JJTBR-HJBW
C
C          DETERMINE IF RADAR IS IN MAIN BEAM OF JAMMER
C
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      IF (LJBW.GT.6.2831853) GO TO 310                                  BID 3360
      IF (RJBW.LT.0.0) GO TO 320                                        BID 3370
      IF (LJBW.GT.JRBRG.AND.RJBW.LT.JRBRG) COFF=1.0                     BID 3380
      GO TO 340                                                         BID 3390
  310 LJBW = LJBW-6.2831853                                             BID 3400
      GO TO 330                                                         BID 3410
  320 RJBW = RJBW+6.2831853                                             BID 3420
  330 IF (LJBW.GT.JRBRG.OR.RJBW.LT.JRBRG) COFF=1.0                      BID 3430
C                                                                       BID 3440
C          DETERMINE IF JAMMER IS IN MAIN BEAM OF RADAR                 BID 3450
C                                                                       BID 3460
  340 LTBRG = TBRG+HRBW                                                 BID 3470
      RTBRG = TBRG-HRBW                                                 BID 3480
      IF (LTBRG.GT.6.2831853) GO TO 350                                 BID 3490
      IF (RTBRG.LT.0.0) GO TO 360                                       BID 3500
      IF (LTBRG.GT.RJBRG.AND.RTBRG.LT.RJBRG) RCOFF=1.0                  BID 3510
      GO TO 380                                                         BID 3520
  350 LTBRG = LTBRG-6.2831853                                           BID 3530
      GO TO 370                                                         BID 3540
  360 RTBRG = RTBRG+6.2831853                                           BID 3550
  370 IF (LTBRG.GT.RJBRG.OR.RTBRG.LT.RJBRG) RCOFF=1.0                   BID 3560
  380 XCOFF = DBLE(COFF*RCOF)                                           BID 3570
      RRJS = (RRJS+(RAID(L,9)/6000.)**2)                                BID 3580
      SUMJP = SUMJP+XCOFF*DBLE(PJ/RRJS)                                 BID 3590
  390 CONTINUE                                                          BID 3600
C                                                                       BID 3610
      IF (SUMJP.LE.0.0D0) GO TO 400                                     BID 3620
      CHAR = DBLE(X(903+LLJ)**2)*SIGMA/SUMJP                            BID 3630
      JFLAG = 1                                                         BID 3640
      IF (IFLAG.EQ.1) GO TO 210                                         BID 3650
      GO TO 110                                                         BID 3660
  400 IF (ND.EQ.1) GO TO 410                                            BID 3670
      R2 = DSQRT((X1+VX*(TD2-TIMC)-XR)**2+(Y1+VY*(TD2-TIMC)-YR)**2+(Z1-ZBID 3680
     1RN)**2)                                                           BID 3690
      IF (R2.GT.X(905+LLJ)) GO TO 420                                   BID 3700
  410 RR = DSQRT((X1+VX*(TD-TIMC)-XR)**2+(Y1+VY*(TD-TIMC)-YR)**2+(Z1-ZRNBID 3710
     1)**2)                                                             BID 3720
      IF (RR.GT.X(905+LLJ)) GO TO 460                                   BID 3730
      GO TO 510                                                         BID 3740
  420 R2 = X(905+LLJ)                                                   BID 3750
      IF (IBM.EQ.0) GO TO 430                                           BID 3760
      IL = IFIX(ASMT(NASM,4)+AMF)                                       BID 3770
      ILL = NASM+90                                                     BID 3780
      CALL TMDASM (IR,IL,NSR,N,VEL,R2,TIMC,TD2,XI,YI,RIP,TLL,ILL)       BID 3790
      GO TO 440                                                         BID 3800
  430 CALL TMDASM (IR,0,NSR,N,VEL,R2,TIMC,TD2,XI,YI,RIP,TLL,IR)         BID 3810
  440 IF (TD2.LT.TL2) GO TO 450                                         BID 3820
      ND = 1                                                            BID 3830
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      GO TO 410                                                         BID 3840
  450 IF (TLL.LT.TL2) TL2=TLL                                           BID 3850
      GO TO 410                                                         BID 3860
  460 RR = X(905+LLJ)                                                   BID 3870
      IF (IBM.EQ.0) GO TO 470                                           BID 3880
      IL = IFIX(ASMT(NASM,4)+AMF)                                       BID 3890
      ILL = NASM+90                                                     BID 3900
      CALL TMDASM (IR,IL,NSR,N,VEL,RR,TIMC,TD,XI,YI,RIP,TLL,ILL)        BID 3910
      GO TO 480                                                         BID 3920
  470 CALL TMDASM (IR,0,NSR,N,VEL,RR,TIMC,TD,XI,YI,RIP,TLL,IR)          BID 3930
  480 IF (TD.LT.TL) GO TO 490                                           BID 3940
      IF (ND.EQ.2) GO TO 500                                            BID 3950
      ND = 0                                                            BID 3960
      GO TO 510                                                         BID 3970
  490 IF (TLL.LT.TL) TL = TLL                                           BID 3980
      GO TO 510                                                         BID 3990
  500 ND = 1                                                            BID 4000
      TD = TD2                                                          BID 4010
      TL = TL2                                                          BID 4020
      RR = R2                                                           BID 4030
  510 IF (X(55).EQ.0.) GO TO 520                                        BID 4040
      CALL GETIMX (IET)                                                 BID 4050
      COOL = IET*.000026                                                BID 4060
      WRITE (6,540) COOL                                                BID 4070
  520 RETURN                                                            BID 4080
C                                                                       BID 4090
  530 FORMAT ('  BIDET IN AT ',F15.8)                                   BID 4100
  540 FORMAT ('  BIDET OUT AT',F15.8)                                   BID 4110
      END                                                               BID 4120

      SUBROUTINE DTIMD (XCOF,COF,M,ROOTR,ROOTI,IER)                     DTM   10
C                                                                       DTM   20
C         DETERMINES THE TIMES OF DETECTION FOR THE BISTATIC RADAR      DTM   30
C         BY SOLVING THE FOURTH ORDER POLYNOMIAL                        DTM   40
C         REAL ROOTS ARE RETURNED IN THE REAL ARRAY WITH THE            DTM   50
C         CORRESPONDING  IMAGINARY ROOTS IN ROOTI.    THE METHOD        DTM   60
C         EMPLOYED IS THAT OF THE NEWTON-RAPHSON ITERATIVE TECH-        DTM   70
C         NIQUE.  THE FINAL ITERATIONS ON EACH ROOT ARE PERFORMED       DTM   80
C         USING THE ORIGINAL POLYNOMIAL RATHER THAN THE REDUCED         DTM   90
C         POLYNOMIAL TO AVOID ACCUMULATED ERRORS IN THE REDUCED         DTM  100
C         POLYNOMIAL                                                    DTM  110
C                                                                       DTM  120
      IMPLICIT REAL*8(A-H),REAL*8(O-Z)                                  DTM  130
      DIMENSION XCOF(1), COF(1), ROOTR(1), ROOTI(1)                     DTM  140
      IFIT = 0                                                          DTM  150
      N = M                                                             DTM  160
      IER = 0                                                           DTM  170
```

```
      IF (XCOF(N+1)) 20,50,20                           DTM  180
   20 IF (N) 30,30,70                                   DTM  190
C                                                       DTM  200
C        SET ERROR CODE TO 1                            DTM  210
C                                                       DTM  220
   30 IER = 1                                           DTM  230
   40 RETURN                                            DTM  240
C                                                       DTM  250
C        SET ERROR CODE TO 4                            DTM  260
C                                                       DTM  270
   50 IER = 4                                           DTM  280
      GO TO 40                                          DTM  290
C                                                       DTM  300
C        SET ERROR CODE TO 2                            DTM  310
C                                                       DTM  320
   60 IER = 2                                           DTM  330
      GO TO 40                                          DTM  340
   70 IF (N-36) 80,80,60                                DTM  350
   80 NX = N                                            DTM  360
      NXX = N+1                                         DTM  370
      N2 = 1                                            DTM  380
      KJ1 = N+1                                         DTM  390
C                                                       DTM  400
      DO 90 L=1,KJ1                                     DTM  410
      MT = KJ1-L+1                                      DTM  420
   90 COF(MT) = XCOF(L)                                 DTM  430
C                                                       DTM  440
C                                                       DTM  450
C        SET INITIAL VALUES                             DTM  460
C                                                       DTM  470
  100 XO = .00500101                                    DTM  480
      YO = 0.01000101                                   DTM  490
C                                                       DTM  500
C        ZERO INITIAL VALUE COUNTER                     DTM  510
C                                                       DTM  520
      IN = 0                                            DTM  530
  110 X = XO                                            DTM  540
C                                                       DTM  550
C        INCREMENT INITIAL VALUES AND COUNTER           DTM  560
C                                                       DTM  570
      XO = -10.0*YO                                     DTM  580
      YO = -10.0*X                                      DTM  590
C                                                       DTM  600
C        SET X AND Y TO CURRENT VALUE                   DTM  610
C                                                       DTM  620
      X = XO                                            DTM  630
      Y = YO                                            DTM  640
      IN = IN+1                                         DTM  650
```

```
      GO TO 130
  120 IFIT = 1
      XPR = X
      YPR = Y
C
C        EVALUATE POLYNOMIAL AND DERIVATIVES
C
  130 ICT = 0
  140 UX = 0.0
      UY = 0.0
      V = 0.0
      YT = 0.0
      XT = 1.0
      U = COF(N+1)
      IF (U) 150,280,150
C
  150 DO 160 I=1,N
      L = N-I+1
      XT2 = X*XT-Y*YT
      YT2 = X*YT+Y*XT
      U = U+COF(L)*XT2
      V = V+COF(L)*YT2
      FI = I
      UX = UX+FI*XT*COF(L)
      UY = UY-FI*YT*COF(L)
      XT = XT2
  160 YT = YT2
C
      SUMSQ = UX*UX+UY*UY
      IF (SUMSQ) 170,240,170
  170 DX = (V*UY-U*UX)/SUMSQ
      X = X+DX
      DY = -(U*UY+V*UX)/SUMSQ
      Y = Y+DY
      IF (DABS(DY)+DABS(DX)-1.0E-05) 220,180,180
C
C        STEP ITERATION COUNTER
C
  180 ICT = ICT+1
      IF (ICT-500) 140,190,190
  190 IF (IFIT) 220,200,220
  200 IF (IN-5) 110,210,210
C
C        SET ERROR CODE TO 3
C
  210 IER = 3
      GO TO 40
C
```

```
  220 DO 230 L=1,NXX
      MT = KJ1-L+1
      TEMP = XCOF(MT)
      XCOF(MT) = COF(L)
  230 COF(L) = TEMP
C
      ITEMP = N
      N = NX
      NX = ITEMP
      IF (IFIT) 260,120,260
  240 IF (IFIT) 250,110,250
  250 X = XPR
      Y = YPR
  260 IFIT = 0
      IF (DABS(Y/X)-1.0E-04) 290,270,270
  270 ALPHA = X+X
      SUMSQ = X*X+Y*Y
      N = N-2
      GO TO 300
  280 X = 0.0
      NX = NX-1
      NXX = NXX-1
  290 Y = 0.0
      SUMSQ = 0.0
      ALPHA = X
      N = N-1
  300 COF(2) = COF(2)+ALPHA*COF(1)
C
      DO 310 L=2,N
  310 COF(L+1) = COF(L+1)+ALPHA*COF(L)-SUMSQ*COF(L-1)
C
  320 ROOTI(N2) = Y
      ROOTR(N2) = X
      N2 = N2+1
      IF (SUMSQ) 330,340,330
  330 Y = -Y
      SUMSQ = 0.0
      GO TO 320
  340 IF (N) 40,40,100
      END

      SUBROUTINE CPA (XI,YI,XO,YO,XP,YP,XC,YC)
C        XI---BOMBER OR ASM START POSITION
C        YI---    "    "    "      "
C        XO---BOMBER END OF GAME POSIT,
C        YO---ASM TARGET SHIP POSIT
C        XP---REFERENCE POINT, IE FIRING SHIP
```

```
C         YP---        "      "    "      "        "                        CPA   70
C         XC---CPA COORDINATES                                               CPA   80
C         YC--- "             "                                              CPA   90
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMCPA  100
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEECPA  110
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOCPA  120
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QCPA  130
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),CPA  140
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4CPA  150
     60),AMF,HISX(100),JACK(40,7),HISA(100)                              CPA  160
      IQ = X(55)                                                         CPA  170
      IF (IQ.EQ.0) GO TO 110                                             CPA  180
      CALL GETIMX (IET)                                                  CPA  190
      T = IET*.000026                                                    CPA  200
      WRITE (6,200) T                                                    CPA  210
  110 DELX = ABS(XO-XP)-0.01                                             CPA  220
      DELY = ABS(YO-YP)-0.01                                             CPA  230
      IF (DELX.LT.0.0.AND.DELY.LT.0.0) GO TO 190                         CPA  240
      DELY = ABS(YI-YO)-0.1                                              CPA  250
      DELX = ABS(XI-XO)-0.1                                              CPA  260
      IF (DELX.LT.0.0.AND.DELY.LT.0.0) GO TO 160                         CPA  270
      IF (DELY) 120,130,130                                              CPA  280
  120 XC = XP                                                            CPA  290
      YC = YI                                                            CPA  300
      GO TO 170                                                          CPA  310
  130 IF (DELX) 140,150,150                                              CPA  320
  140 XC = XI                                                            CPA  330
      YC = YP                                                            CPA  340
      GO TO 170                                                          CPA  350
  150 Q = (YI-YO)/(XI-XO)                                                CPA  360
      XC = ((YP-YO)+(XP/Q)+(Q*XO))/(Q+1/Q)                               CPA  370
      YC = YP-(XC-XP)/Q                                                  CPA  380
      GO TO 170                                                          CPA  390
  160 XC = XI                                                            CPA  400
      YC = YI                                                            CPA  410
  170 IF (IQ.EQ.0) GO TO 180                                             CPA  420
      CALL GETIMX (IET)                                                  CPA  430
      T = IET*.000026                                                    CPA  440
      WRITE (6,210) T                                                    CPA  450
  180 RETURN                                                             CPA  460
  190 XC = XO                                                            CPA  470
      YC = YO                                                            CPA  480
      GO TO 170                                                          CPA  490
C                                                                        CPA  500
  200 FORMAT ('   CPA IN AT',F15.8)                                      CPA  510
  210 FORMAT ('   CPA OUT AT',F15.8)                                     CPA  520
      END                                                                CPA  530
```

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      SUBROUTINE REACT (ICL,ITP,DELAY)                                  REA   10
C                                                                       REA   20
C        THIS SUBROUTINE COMPUTES THE REACTION TIME DELAY FOR           REA   30
C        DETECTION, ACQUISITION, FIRING, ETC., WHERE                    REA   40
C          ICL---------CLASS OF THE REACTION TIME DISTRIBUTION,         REA   50
C                      IE. WDE, FIRE, DETECT, ETC.                      REA   60
C          ITP---------TYPE OF DISTRIBUTION, UP TO FIVE PER CLASS       REA   70
C          DELAY-------OUTPUT                                           REA   80
C                                                                       REA   90
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMREA  100
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEEREA  110
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOREA  120
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QREA  130
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),REA  140
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4REA  150
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             REA  160
      ID = 1400+(ICL-1)*50                                              REA  170
      CALL RANDOM (ISEED,Z,1)                                           REA  180
      X(13) = X(13)+1.                                                  REA  190
      INT = Z*10                                                        REA  200
      IF (INT.EQ.0) GO TO 120                                           REA  210
      IF (INT.EQ.10) INT = 9                                            REA  220
      ID = ID+(ITP-1)*10+INT                                            REA  230
      RANGE = X(ID+1)-X(ID)                                             REA  240
      CALL RANDOM (ISEED,Z,1)                                           REA  250
      X(13) = X(13)+1.                                                  REA  260
      DELAY = X(ID)+Z*RANGE                                             REA  270
  110 RETURN                                                            REA  280
  120 RANGE = X(ID+1)                                                   REA  290
      CALL RANDOM (ISEED,Z,1)                                           REA  300
      X(13) = X(13)+1.                                                  REA  310
      DELAY = RANGE*Z                                                   REA  320
      GO TO 110                                                         REA  330
      END                                                               REA  340
```

```
      SUBROUTINE PRIOR (M,K,NMS,NB,RGE,NC,TIME,MM,MC,XM,YM)             PRI   10
C                                                                       PRI   20
C        THIS SUBROUTINE DETERMINES IF THERE IS A MORE THREATENING      PRI   30
C        TARGET TO BE ENGAGED AT THIS TIME BY THIS SHIP,THIS SYSTEM     PRI   40
C        AND THIS DIRECTOR. PRESENT LOGIC CONSIDERS THE CLOSEST         PRI   50
C        UNENGAGED TARGET THE MOST THREATENING.                         PRI   60
C                                                                       PRI   70
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMPRI   80
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEEPRI   90
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOPRI  100
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QPRI  110
```

```
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),PRI 120
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4PRI 130
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             PRI 140
C                                                                       PRI 150
      IQ = X(55)                                                        PRI 160
      IF (IQ.EQ.0) GO TO 110                                            PRI 170
      CALL GETIMX (MV)                                                  PRI 180
      DELTAX = MV*2.6E-5                                                PRI 190
      WRITE (6,210) DELTAX                                              PRI 200
  110 IF (M.GT.90) GO TO 120                                            PRI 210
      CALL LOCTIM (M,TIME,3,XP,YP)                                      PRI 220
      GO TO 130                                                         PRI 230
  120 CALL ASMTIM (M,TIME,XP,YP)                                        PRI 240
  130 DELTAX = ABS(SHIP(K,2)-XP)                                        PRI 250
      DELTAY = ABS(SHIP(K,3)-YP)                                        PRI 260
      IF (DELTAX.LT.5.0E-5) DELTAX=5.0E-5                               PRI 270
      IF (DELTAY.LT.5.0E-5) DELTAY=5.0E-5                               PRI 280
      RGI = SQRT(DELTAX**2+DELTAY**2)                                   PRI 290
      CHECK = RGE/RGI                                                   PRI 300
      MM = M                                                            PRI 310
      MC = NC                                                           PRI 320
      XM = XP                                                           PRI 330
      YM = YP                                                           PRI 340
C                                                                       PRI 350
C        GET ANOTHER CANDIDATE IF THERE IS ONE                          PRI 360
C                                                                       PRI 370
  140 CALL TARGET (TIME,MT,MORE)                                        PRI 380
      IF (MORE.EQ.0) GO TO 170                                          PRI 390
      IU = MT-300000000+2                                               PRI 400
      MV = IU*1.0D-5                                                    PRI 410
      KP = MV*100000                                                    PRI 420
      ID = IU-KP                                                        PRI 430
      KP = ID*1.0D-3                                                    PRI 440
      IF (KP.NE.K) GO TO 140                                            PRI 450
      KT = KP*1000                                                      PRI 460
      JP = ID-KT                                                        PRI 470
      MSO = JP*1.0E-2                                                   PRI 480
      IF (MSO.NE.NMS) GO TO 140                                         PRI 490
      KP = NMS*100                                                      PRI 500
      ID = JP-KP                                                        PRI 510
      NBO = ID*1.0E-1                                                   PRI 520
      IF (NBO.NE.NB) GO TO 140                                          PRI 530
      KP = NB*10                                                        PRI 540
      NCO = ID-KP-2                                                     PRI 550
      IF (MV.GT.90) GO TO 150                                           PRI 560
      CALL LOCTIM (MV,TIME,3,XP,YP)                                     PRI 570
      GO TO 160                                                         PRI 580
  150 CALL ASMTIM (MV,TIME,XP,YP)                                       PRI 590
```

```
  160 DELTAX = ABS(SHIP(K,2)-XP)                                          PRI  600
      DELTAY = ABS(SHIP(K,3)-YP)                                          PRI  610
      IF (DELTAX.LT.5.0E-5) DELTAX=5.0E-5                                 PRI  620
      IF (DELTAY.LT.5.0E-5) DELTAY=5.0E-5                                 PRI  630
      RGI = SQRT(DELTAX**2+DELTAY**2)                                     PRI  640
C                                                                         PRI  650
C        COMPARE THREAT VALUES                                            PRI  660
C                                                                         PRI  670
      CHERRY = RGE/RGI                                                    PRI  680
      IF (CHECK.GE.CHERRY) GO TO 140                                      PRI  690
      CHECK = CHERRY                                                      PRI  700
      MM = MV                                                             PRI  710
      MC = NCO                                                            PRI  720
      XM = XP                                                             PRI  730
      YM = YP                                                             PRI  740
      IUNYT = MT                                                          PRI  750
      GO TO 140                                                           PRI  760
  170 IF (MM.EQ.M) GO TO 180                                              PRI  770
      CALL REMOVE (IUNYT)                                                 PRI  780
      IUNYT = M*100000+K*1000+NMS*100+NB*10+NC                            PRI  790
      CALL STOREV (TIME,3,IUNYT)                                          PRI  800
  180 IF (X(9).EQ.0.) GO TO 190                                           PRI  810
      NSB = K*100+NMS*10+NB                                               PRI  820
      WRITE (6,220) M,MM,NSB,NC,MC                                        PRI  830
  190 IF (IQ.EQ.0) GO TO 200                                              PRI  840
      CALL GETIMX (MV)                                                    PRI  850
      DELTAY = MV*2.6E-5                                                  PRI  860
      WRITE (6,230) DELTAY                                                PRI  870
  200 RETURN                                                              PRI  880
  210 FORMAT (' PRIOR IN AT',F15.8)                                       PRI  910
  220 FORMAT ('0',' PRIOR DEBUG DATA     INPUT TGT',I4,' OUTPUT TGT',I4/(PRI  920
     122X,'BATTERY NUMBER',I5/(22X,'INPUT CHANNEL',I2,' OUTPUT CHANNEL',PRI  930
     2I2)))                                                               PRI  940
  230 FORMAT (' PRIOR OUT AT',F15.8)                                      PRI  950
      END                                                                 PRI  960


      SUBROUTINE RCHECK (IT,IR,K)                                         RECK  10
C                                                                         RECK  20
C        IT.........TARGET NUMBER                                         RECK  30
C        IR.........RAIDER NUMBER                                         RECK  40
C        K..........FLAG FOR GO/NOGO ON TARGET ASSIGNMENT                 RECK  50
C                                                                         RECK  60
C        THIS SUBROUTINE EVALUATES THE PROSPECTIVE TARGET TO              RECK  70
C        SEE IF THE RAIDER CAN IN FACT "SEE" THE TARGET.                  RECK  80
C                                                                         RECK  90
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMRECK 100
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEERECK 110
```

```
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASORECK 120
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QRECK 130
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),RECK 140
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4RECK 150
     60),AMF,HISX(100),JACK(40,7),HISA(100)                            RECK 160
      IQ = X(55)                                                        RECK 170
      IF (IQ.EQ.0) GO TO 20                                             RECK 180
      CALL GETIMX (IET)                                                 RECK 190
      TM = .000026*IET                                                  RECK 200
      WRITE (6,70) TM                                                   RECK 210
C                                                                       RECK 220
C        GET THE DISTANCE FROM THE RED RAIDER TO THE BLUE SHIP          RECK 230
C                                                                       RECK 240
   20 XS = RAID(IR,3)                                                   RECK 250
      YS = RAID(IR,4)                                                   RECK 260
      XT = SHIP(IT,2)                                                   RECK 270
      YT = SHIP(IT,3)                                                   RECK 280
      DELX = ABS(XS-XT)                                                 RECK 290
      IF (DELX.LT..00005) DELX=.00005                                   RECK 300
      DELY = ABS(YS-YT)                                                 RECK 310
      IF (DELY.LT..00005) DELY=.00005                                   RECK 320
      DIS = DELX**2+DELY**2                                             RECK 330
      ID = IFIX(X(1201+(IT-1)*4)+AMF)                                   RECK 340
      IC = 108+(ID-1)*40                                                RECK 350
      IB = IC+6                                                         RECK 360
      HT = 15.                                                          RECK 370
C                                                                       RECK 380
C        SET THE TARGET SHIP HEIGHT TO A NOMINAL VALUE OF 15            RECK 390
C        FEET AND THEN PROCEED TO DETERMINE THE HEIGHT OF HIS HIGHEST   RECK 400
C        RADAR, IF HE HAS ONE.                                          RECK 410
C                                                                       RECK 420
      DO 30 M=IC,IB                                                     RECK 430
      IF (HT.LT.X(M)) HT = X(M)                                         RECK 440
   30 CONTINUE                                                          RECK 450
C                                                                       RECK 460
C        DETERMINE THE MUTUAL RADAR HORIZON BETWEEN THE ATTACKER        RECK 470
C        AND THE TARGET. GET THE MAX RANGE FOR THE ATTACKER'S RADAR.    RECK 480
C        IF THE COMBINED RADAR HORIZONS ARE LESS THAN THE ACTUAL        RECK 490
C        DISTANCE, OR THE ACTUAL DISTANCE IS GREATER THQN THE RADAR'S   RECK 500
C        CAPABILITY, SET THE FLAG TO NO GO AND EXIT. OTHERWISE SET      RECK 510
C        THE FLAG TO OK AND EXIT.                                       RECK 520
C                                                                       RECK 530
      HTR = X(81)*SQRT(HT)                                              RECK 540
      RTR = RAID(IR,10)                                                 RECK 550
      RADAR = RTR+HTR                                                   RECK 560
      RADAR2 = RADAR**2                                                 RECK 570
      IF (RADAR2.LT.DIS) GO TO 40                                       RECK 580
      IC = IFIX(X(2201+(IR-1)*6)+AMF)                                   RECK 590
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      IB = IFIX(X(1807+(IC-1)*20)+AMF)                                  RECK 600
      RR = X(905+(IB-1)*20)                                             RECK 610
      RR2 = RR**2                                                       RECK 620
      IF (DIS.GT.RR2) GO TO 40                                          RECK 630
      K = 0                                                             RECK 640
      GO TO 50                                                          RECK 650
   40 K = 1                                                             RECK 660
   50 IF (IQ.EQ.0) GO TO 60                                             RECK 670
      CALL GETIMX (IET)                                                 RECK 680
      TM = .000026*IET                                                  RECK 690
      WRITE (6,80) TM                                                   RECK 700
   60 RETURN                                                            RECK 710
C                                                                       RECK 720
   70 FORMAT ('    RCHECK IN AT',F15.8)                                 RECK 730
   80 FORMAT ('    RCHECK OUT AT',F15.8)                                RECK 740
      END                                                               RECK 750


      SUBROUTINE TMDASM (IRAID,ITS,ISAMBT,NFS,VEL,SRG,TML,TIME,XI,YI,RIPTMD   10
     1,TIML,M)                                                          TMD   20
C                                                                       TMD   30
C         THIS SUBROUTINE  COMPUTES THE TIME OF ENTERING AND            TMD   40
C         LEAVING A GIVEN ENGAGEMENT CIRCLE                             TMD   50
C                                                                       TMD   60
C                                                                       TMD   70
C             IRAID------------RAID LAUNCHING THE ASM                   TMD   80
C             ITS--------------TARGET SHIP                              TMD   90
C             ISAMBAT----------SAM BATTERY NUMBER                       TMD  100
C             NFS--------------NUMBER OF THE SAM FIRING SHIP            TMD  110
C             VEL--------------ASM VELOCITY (SPEED IN NM/MIN)           TMD  120
C             SRG--------------MAXIMUM SAM RANGE FOR THIS ALTITUDE AND TYPTMD  130
C             TML--------------TIME OF ASM LAUNCH                       TMD  140
C             TIME-------------(OUTPUT) TIME OF MAX RANGE SAM INTERCEPT TMD  150
C             XI---------------(OUTPUT) X POSIT   MAX INTERCEPT RANGE   TMD  160
C             YI---------------(OUTPUT) Y POSIT   MAX INTERCEPT RANGE   TMD  170
C             RIP--------------(OUTPUT) DISTANCE TO INTERCEPT OR        TMD  180
C                              DETECTION                                TMD  190
C             TIML-------------(OUTPUT) TIME OF OUT OF RANGE            TMD  200
C             M----------------AIRBORNE TARGET NUMBER                   TMD  210
C                                                                       TMD  220
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMTMD  230
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEETMD  240
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOTMD  250
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QTMD  260
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),TMD  270
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4TMD  280
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             TMD  290
      IQ = X(55)                                                        TMD  300
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      IF (VEL.EQ.0.) VEL = .0001                                        TMD  310
      IF (IQ.EQ.0) GO TO 20                                             TMD  320
      CALL GETIMX (IET)                                                 TMD  330
      TIMES = IET*.000026                                               TMD  340
      WRITE (6,270) TIMES                                               TMD  350
   20 IFLAG = 0                                                         TMD  360
      KFLAG = 0                                                         TMD  370
C                                                                       TMD  380
C        DETERMINE THE PRESENT RANGE                                    TMD  390
C                                                                       TMD  400
      DEX = ABS(SHIP(NFS,2)-RAID(IRAID,3))                              TMD  410
      DEY = SHIP(NFS,3)-RAID(IRAID,4)                                   TMD  420
      IF (ABS(DEY).LT.0.00005) DEY=.00005                               TMD  430
      IF (DEX.LT..00005) DEX=.00005                                     TMD  440
      DIP = DEX**2+DEY**2                                               TMD  450
      RIP = SQRT(DIP)                                                   TMD  460
      IF (RIP.GT.SRG) GO TO 30                                          TMD  470
      XI = RAID(IRAID,3)                                                TMD  480
      YI = RAID(IRAID,4)                                                TMD  490
      TIME = TML                                                        TMD  500
      IFLAG = 1                                                         TMD  510
      IF (VEL.LT..005) GO TO 260                                        TMD  520
      GO TO 40                                                          TMD  530
   30 RIP = SRG                                                         TMD  540
      IF (VEL.LT..005) GO TO 200                                        TMD  550
C                                                                       TMD  560
C         SOLVE THE LINEAR EQUATION FOR THE TARGET                      TMD  570
C                                                                       TMD  580
   40 DELTAX = RAID(IRAID,14)-RAID(IRAID,3)                             TMD  590
      DELTAY = RAID(IRAID,15)-RAID(IRAID,4)                             TMD  600
      IF (ABS(DELTAX).LT.5.0E-2) GO TO 50                               TMD  610
      SLM = DELTAY/DELTAX                                               TMD  620
      GO TO 60                                                          TMD  630
   50 B = -2*SHIP(NFS,3)                                                TMD  640
      C = (RAID(IRAID,3)-SHIP(NFS,2))**2+SHIP(NFS,3)**2-SRG**2          TMD  650
      TEST = B**2-4.*C                                                  TMD  660
      IF (TEST.LE.0.) GO TO 200                                         TMD  670
      TOAST = SQRT(TEST)                                                TMD  680
      X1 = RAID(IRAID,3)                                                TMD  690
      X2 = X1                                                           TMD  700
      Y1 = (-B+TOAST)/2.                                                TMD  710
      Y2 = (-B-TOAST)/2.                                                TMD  720
      KFLAG = 1                                                         TMD  730
      GO TO 80                                                          TMD  740
   60 B1 = RAID(IRAID,15)-SLM*RAID(IRAID,14)                            TMD  750
      XS = SHIP(NFS,2)                                                  TMD  760
      YS = SHIP(NFS,3)                                                  TMD  770
C                                                                       TMD  780
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C          SOLVE THE JOINT QUADRATIC EQUATION                           TMD  790
C                                                                       TMD  800
      A = SLM**2+1.                                                     TMD  810
      B = 2.*(SLM*(B1-YS)-XS)                                           TMD  820
      C = XS**2+(B1-YS)**2-SRG**2                                       TMD  830
      TEST = B**2-4.*A*C                                                TMD  840
      IF (TEST) 200,200,70                                              TMD  850
   70 ROOT = SQRT(TEST)                                                 TMD  860
      X1 = (-B+ROOT)/(2.*A)                                             TMD  870
      X2 = (-B-ROOT)/(2.*A)                                             TMD  880
      Y1 = SLM*X1+B1                                                    TMD  890
      Y2 = SLM*X2+B1                                                    TMD  900
   80 DELX = ABS(X1-RAID(IRAID,3))                                      TMD  910
      IF (DELX.LT..00005) DELX=.00005                                   TMD  920
      DELY = ABS(Y1-RAID(IRAID,4))                                      TMD  930
      IF (DELY.LT..00005) DELY=.00005                                   TMD  940
      D1 = SQRT(DELX**2+DELY**2)                                        TMD  950
      DELX = ABS(X2-RAID(IRAID,3))                                      TMD  960
      IF (DELX.LT..00005) DELX=.00005                                   TMD  970
      DELY = ABS(Y2-RAID(IRAID,4))                                      TMD  980
      IF (DELY.LT..00005) DELY=.00005                                   TMD  990
      D2 = SQRT(DELX**2+DELY**2)                                        TMD 1000
      IF (IFLAG.EQ.1) GO TO 120                                         TMD 1010
      IF (KFLAG.EQ.1) GO TO 160                                         TMD 1020
      DIF = ABS(DELTAX)                                                 TMD 1030
      IF (D2.LT.D1) GO TO 100                                           TMD 1040
      DIC = ABS(RAID(IRAID,14)-X1)                                      TMD 1050
   90 IF (DIF.LT.DIC) GO TO 200                                         TMD 1060
C                                                                       TMD 1070
C          DETERMINE THE INTERSECTION TIMES                             TMD 1080
C                                                                       TMD 1090
      XI = X1                                                           TMD 1100
      YI = Y1                                                           TMD 1110
      TIME = TML+D1/VEL                                                 TMD 1120
      TIML = TML+D2/VEL                                                 TMD 1130
      GO TO 220                                                         TMD 1140
  100 DIC = ABS(RAID(IRAID,14)-X2)                                      TMD 1150
  110 IF (DIF.LT.DIC) GO TO 200                                         TMD 1160
      XI = X2                                                           TMD 1170
      YI = Y2                                                           TMD 1180
      TIME = TML+D2/VEL                                                 TMD 1190
      TIML = TML+D1/VEL                                                 TMD 1200
      GO TO 220                                                         TMD 1210
  120 IF (KFLAG.EQ.1) GO TO 180                                         TMD 1220
      IF (DELTAX.LT.0.) GO TO 150                                       TMD 1230
      IF (X1.LT.X2) GO TO 140                                           TMD 1240
  130 TIML = TML+D1/VEL                                                 TMD 1250
      GO TO 220                                                         TMD 1260
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  140 TIML = TML+D2/VEL                                                 TMD 1270
      GO TO 220                                                         TMD 1280
  150 IF (X1.LT.X2) GO TO 130                                           TMD 1290
      GO TO 140                                                         TMD 1300
  160 DIF = ABS(DELTAY)                                                 TMD 1310
      IF (D2.LT.D1) GO TO 170                                           TMD 1320
      DIC = ABS(RAID(IRAID,15)-Y1)                                      TMD 1330
      GO TO 90                                                          TMD 1340
  170 DIC = ABS(RAID(IRAID,15)-Y2)                                      TMD 1350
      GO TO 110                                                         TMD 1360
  180 IF (DELTAY.LT.0.) GO TO 190                                       TMD 1370
      IF (Y1.LT.Y2) GO TO 140                                           TMD 1380
      GO TO 130                                                         TMD 1390
  190 IF (Y1.LT.Y2) GO TO 130                                           TMD 1400
      GO TO 140                                                         TMD 1410
  200 TIME = 9120.                                                      TMD 1420
      XI = 9999.                                                        TMD 1430
      YI = 9999.                                                        TMD 1440
      RIP = 0.                                                          TMD 1450
      IF (X(57).EQ.0.) GO TO 240                                        TMD 1460
      IF (ITS.EQ.0) GO TO 210                                           TMD 1470
      WRITE (6,280) IRAID,ITS,ISAMBT,NFS,M                              TMD 1480
      GO TO 240                                                         TMD 1490
  210 WRITE (6,310) M,NFS                                               TMD 1500
      GO TO 240                                                         TMD 1510
  220 IF (X(57).EQ.0.) GO TO 240                                        TMD 1520
      IF (ITS.EQ.0) GO TO 230                                           TMD 1530
      WRITE (6,290) M,NFS,ITS,SRG,TIME,TIML                             TMD 1540
      GO TO 240                                                         TMD 1550
  230 WRITE (6,320) M,NFS,ISAMBT,SRG,TIME,TIML                          TMD 1560
  240 IF (IQ.EQ.0) GO TO 250                                            TMD 1570
      CALL GETIMX (IET)                                                 TMD 1580
      TIMES = .000026*IET                                               TMD 1590
      WRITE (6,300) TIMES                                               TMD 1600
  250 RETURN                                                            TMD 1610
  260 TIML = X(82)                                                      TMD 1620
      GO TO 220                                                         TMD 1630
C                                                                       TMD 1640
  270 FORMAT ('         TMDASM IN AT ',F15.8)                           TMD 1650
  280 FORMAT (' NO ENGAGEMENT POSSIBLE, RAID ',I4,' TARGET SHIP',I3, '  TMD 1660
     1 BATTERY',I2,' MISSILE SHIP',I3,' ASM',I3)                        TMD 1670
  290 FORMAT ('0','  ENGAGEMENT DATA, ASM',I4,' AND SHIP',I3,/(' TARGET TMD 1680
     1SHIP   DETEC RANGE   GAIN CONTACT   LOOSE CONTACT'/(I6,9X,F10.3,6XTMD 1690
     2,F7.3,9X,F7.3)))                                                  TMD 1700
  300 FORMAT ('       TMDASM OUT AT ',F15.8)                            TMD 1710
  310 FORMAT ('0','  NO ENGAGEMENT POSSIBLE BETWEEN BOMBER',I3,' AND SHITMD 1720
     1P',I3)                                                            TMD 1730
  320 FORMAT ('0','  ENGAGEMENT DATA, BOMBER',I3,' AND SHIP',I3/(4X,'BATTMD 1740
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      SUBROUTINE TMDBOM (IR,RGE,T)                                      TBM   10
C                                                                       TBM   20
      CCMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMTBM   30
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEETBM   40
     2D,MANBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOTBM   50
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QTBM   60
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),TBM   70
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4TBM   80
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             TBM   90
C                                                                       TBM  100
C        COMPUTES THE TIME THE RAIDER WILL REACH A GIVEN RANGE FROM     TBM  110
C        FORCE CENTER.                                                  TBM  120
C        IR......BOMBER NUMBER                                          TBM  130
C        RGE.....GIVEN RANGE IN MILES                                   TBM  140
C        T.......(OUTPUT) TIME OF ATTAINING THE RANGE. IF PRESENT       TBM  150
C                GAME TIME.PUTS BOMBER INSIDE GIVEN RANGE, PRESENT      TBM  160
C                GAME TIME IS RETURNED.                                 TBM  170
C                                                                       TBM  180
      IQ = X(55)                                                        TBM  190
      IF (IQ.EQ.0) GO TO 20                                             TBM  200
      CALL GETIMX (IET)                                                 TBM  210
      TM = .000026*IET                                                  TBM  220
      WRITE (6,110) TM                                                  TBM  230
C                                                                       TBM  240
C        COMPUTE PRESENT RAIDER RANGE FROM FORCE CENTER                 TBM  250
C                                                                       TBM  260
   20 DIP = RAID(IR,3)**2+RAID(IR,4)**2                                 TBM  270
      RIP = SQRT(DIP)                                                   TBM  280
      IF (RIP.GT.RGE) GO TO 30                                          TBM  290
      T = RAID(IR,2)                                                    TBM  300
      GO TO 80                                                          TBM  310
   30 DELTAX = RAID(IR,5)-RAID(IR,3)                                    TBM  320
      IP = IFIX(X(2201+(IR-1)*6)+AMF)                                   TBM  330
      VEL = X(1814+(IP-1)*20)                                           TBM  340
      DELTAY = RAID(IR,6)-RAID(IR,4)                                    TBM  350
C                                                                       TBM  360
C        SOLVE THE LINEAR EQUATION FOR RAIDER TRACK AND THE             TBM  370
C        QUADRATIC FOR INPUT RANGE SIMULTANEOUSLY                       TBM  380
C                                                                       TBM  390
      IF (ABS(DELTAX).LT.5.0E-2) GO TO 40                               TBM  400
      SLM = DELTAY/DELTAX                                               TBM  410
      GO TO 50                                                          TBM  420
   40 IF (ABS(RAID(IR,3)).GE.RGE.OR.DELTAY*RAID(IR,4).GT.0.) GO TO 100  TBM  430
      IF (VEL.EQ.0.) GO TO 100
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      T = RAID(IR,2)+(ABS(RAID(IR,4))-SQRT(RGE**2-RAID(IR,3)**2))/VEL     TBM  440
      IF (T.GT.X(82).OR.T.LT.RAID(IR,2)) GO TO 100                        TBM  450
      GO TO 80                                                            TBM  460
   50 BA = RAID(IR,6)-SLM*RAID(IR,5)                                      TBM  470
      A = SLM**2+1.                                                       TBM  480
      B = 2.*SLM*BA                                                       TBM  490
      C = BA**2-RGE**2                                                    TBM  500
      TEST = B**2-4.*A*C                                                  TBM  510
      IF (TEST) 100,100,60                                                TBM  520
   60 RCOT = SQRT(TEST)                                                   TBM  530
      X1 = (-B+ROOT)/(2.*A)                                               TBM  540
      X2 = (-B-ROOT)/(2.*A).                                              TBM  550
      Y1 = SLM*X1+BA                                                      TBM  560
      Y2 = SLM*X2+BA                                                      TBM  570
      DELX = ABS(X1-RAID(IR,3))                                           TBM  580
      IF (DELX.LT..00005) DELX=.00005                                     TBM  590
      DELY = ABS(Y1-RAID(IR,4))                                           TBM  600
      IF (DELY.LT..00005) DELY=.00005                                     TBM  610
      D1 = DELX**2+DELY**2                                                TBM  620
      DELX = ABS(X2-RAID(IR,3))                                           TBM  630
      IF (DELX.LT..00005) DELX=.00005                                     TBM  640
      DELY = ABS(Y2-RAID(IR,4))                                           TBM  650
      IF (DELY.LT..00005) DELY=.00005                                     TBM  660
      D2 = DELX**2+DELY**2                                                TBM  670
      IF (VEL.EQ.0.) GO TO 100                                            TBM  680
      DIF = ABS(RAID(IR,5)-RAID(IR,3))                                    TBM  690
      IF (D2.LT.D1) GO TO 70                                              TBM  700
      DIC = ABS(RAID(IR,5)-X1)                                            TBM  710
      IF (DIF.LT.DIC) GO TO 100                                           TBM  720
C                                                                         TBM  730
C        COMPUTE TIME RAIDER IS WITHIN GIVEN RANGE                        TBM  740
C                                                                         TBM  750
      DIX = SQRT(D1)                                                      TBM  760
      T = RAID(IR,2)+DIX/VEL                                              TBM  770
      GO TO 80                                                            TBM  780
   70 DIC = ABS(RAID(IR,5)-X2)                                            TBM  790
      IF (DIF.LT.DIC) GO TO 100                                           TBM  800
      DIX = SQRT(D2)                                                      TBM  810
      T = RAID(IR,2)+DIX/VEL                                              TBM  820
   80 IF (IQ.EQ.0) GO TO 90                                               TBM  830
      CALL GETIMX (IET)                                                   TBM  840
      TM = IET*.000026                                                    TBM  850
      WRITE (6,120) TM                                                    TBM  860
   90 RETURN                                                              TBM  870
  100 T = 9120.                                                           TBM  880
      GO TO 80                                                            TBM  890
C                                                                         TBM  900
  110 FORMAT ('    TMDBOM IN AT',F15.8)                                   TBM  910
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  120 FORMAT ('  TMDBOM OUT AT',F15.8)                                  TBM  920
      END                                                               TBM  930

      SUBROUTINE ZLNKA (A,KEY,N)                                        ZLKA  10
C                                                                       ZLKA  20
C        THIS SUBROUTINE CAN BE FOUND IN THE NPGS SUBROUTINE            ZLKA  30
C        LIBRARY UNDER THE NAME SHSORT                                  ZLKA  40
C                                                                       ZLKA  50
C        THE SUBROUTINE REORDERS THE INPJT ARRAY "A" FROM SMALLEST      ZLKA  60
C        TO LARGEST, AND SIMULTANEOUSLY REORDERS THE INTEGER            ZLKA  70
C        ARRAY "KEY" TO THE SAME ORDER AS "A".                          ZLKA  80
C                                                                       ZLKA  90
      DIMENSION A(N), KEY(N)                                            ZLKA 100
      M1 = 1                                                            ZLKA 110
   20 M1 = M1*2                                                         ZLKA 120
      IF (M1.LE.N) GO TO 20                                             ZLKA 130
      M1 = M1/2-1                                                       ZLKA 140
      MM = MAXO(M1/2,1)                                                 ZLKA 150
      GO TO 40                                                          ZLKA 160
   30 MM = MM/2                                                         ZLKA 170
      IF (MM.LE.0) GO TO 70                                             ZLKA 180
   40 K = N-MM                                                          ZLKA 190
C                                                                       ZLKA 200
      DO 60 J=1,K                                                       ZLKA 210
      II = J                                                            ZLKA 220
   50 IM = II+MM                                                        ZLKA 230
      IF (A(IM).GE.A(II)) GO TO 60                                      ZLKA 240
      TEMP = A(II)                                                      ZLKA 250
      IT = KEY(II)                                                      ZLKA 260
      A(II) = A(IM)                                                     ZLKA 270
      KEY(II) = KEY(IM)                                                 ZLKA 280
      A(IM) = TEMP                                                      ZLKA 290
      KEY(IM) = IT                                                      ZLKA 300
      II = II-MM                                                        ZLKA 310
      IF (II.GT.0) GO TO 50                                             ZLKA 320
   60 CONTINUE                                                          ZLKA 330
C                                                                       ZLKA 340
      GC TO 30                                                          ZLKA 350
   70 RETURN                                                            ZLKA 360
      END                                                               ZLKA 370

      SUBROUTINE TJSORT (A,N)                                           TJS   10
C                                                                       TJS   20
C      ID:         M1-NPG-SHSORT  (F-IV)                                TJS   30
C                                                                       TJS   40
C       A  -  ARRAY OF NUMBERS TO BE SORTED. THIS ARRAY IS SORTED       TJS   50
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C              (RE-ORDERED) BY A SHELL SORT.                            TJS   60
C        N  -  NUMBER OF MEMBERS IN ARRAY  "A".                         TJS   70
C                                                                       TJS   80
      DIMENSION A(N)                                                    TJS   90
      M1 = 1                                                            TJS  100
   20 M1 = M1*2                                                         TJS  110
      IF (M1.LE.N) GO TO 20                                             TJS  120
      M1 = M1/2-1                                                       TJS  130
      MM = MAX0(M1/2,1)                                                 TJS  140
      GO TO 40                                                          TJS  150
   30 MM = MM/2                                                         TJS  160
      IF (MM.LE.0) GO TO 70                                             TJS  170
   40 K = N-MM                                                          TJS  180
C                                                                       TJS  190
      DO 60 J=1,K                                                       TJS  200
      II = J                                                            TJS  210
   50 IM = II+MM                                                        TJS  220
      IF (A(IM).GE.A(II)) GO TO 60                                      TJS  230
      TEMP = A(II)                                                      TJS  240
      A(II) = A(IM)                                                     TJS  250
      A(IM) = TEMP                                                      TJS  260
      II = II-MM                                                        TJS  270
      IF (II.GT.0) GO TO 50                                             TJS  280
   60 CONTINUE                                                          TJS  290
C                                                                       TJS  300
      GO TO 30                                                          TJS  310
   70 RETURN                                                            TJS  320
      END                                                               TJS  330

      SUBROUTINE LOCTIM (K,T,IND,XP,YP)                                 LOC   10
C                                                                       LOC   20
C        THIS SUBROUTINE COMPUTES THE PRESENT, FUTURE OR PAST BOMBER    LOC   30
C        POSITION. THE INPUTS ARE:                                      LOC   40
C             K-----------BOMBER NUMBER                                 LOC   50
C             T-----------THE TIME OF INTEREST                          LOC   60
C             IND---------AN INDICATOR;  DO YOU WANT THIS INFORMATION   LOC   70
C                         STORED IN THE RAID ARRAY?                     LOC   80
C             XP----------(OUTPUT) POISTION AT TIME T.                  LOC   90
C             YP----------(OUTPUT) POISTION AT TIME T.                  LOC  100
C                                                                       LOC  110
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMLOC  120
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEELOC  130
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOLOC  140
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QLOC  150
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),LOC  160
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4LOC  170
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             LOC  180
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      IQ = X(55)                                                        LOC  190
      IF (IQ.EQ.0) GO TO 20                                             LOC  200
      CALL GETIMX (IET)                                                 LOC  210
      TIMES = IET*.000026                                               LOC  220
      WRITE (6,70) TIMES                                                LOC  230
   20 ID = IFIX(RAID(K,1)+AMF)                                          LOC  240
      VEL = X(ID+13)                                                    LOC  250
      PTIME = RAID(K,2)                                                 LOC  260
      DL = (T-PTIME)*VEL                                                LOC  270
      YZ = RAID(K,4)                                                    LOC  280
      XZ = RAID(K,3)                                                    LOC  290
      DELTAX = XZ-RAID(K,5)                                             LOC  300
      IF (ABS(DELTAX).LT..00005) DELTAX=0.0                             LOC  310
      DELTAY = YZ-RAID(K,6)                                             LOC  320
      IF (ABS(DELTAY).LT..00005) DELTAY=0.0                             LOC  330
      D = SQRT(DELTAX**2+DELTAY**2)                                     LOC  340
      IF (D.EQ.0.) GO TO 60                                             LOC  350
      DT = DL/D                                                         LOC  360
      XP = XZ-DELTAX*DT                                                 LOC  370
      YP = YZ-DELTAY*DT                                                 LOC  380
   30 IF (IND.NE.5) GO TO 40                                            LOC  390
      RAID(K,4) = YP                                                    LOC  400
      RAID(K,3) = XP                                                    LOC  410
      RAID(K,2) = T                                                     LOC  420
   40 IF (IQ.EQ.0) GO TO 50                                             LOC  430
      CALL GETIMX (IET)                                                 LOC  440
      TIMES = IET*.000026                                               LOC  450
      WRITE (6,80) TIMES                                                LOC  460
   50 RETURN                                                            LOC  470
   60 XP = XZ                                                           LOC  480
      YP = YZ                                                           LOC  490
      GO TO 30                                                          LOC  500
C                                                                       LOC  510
   70 FORMAT ('     LOCTIM IN AT',F15.8)                                LOC  520
   80 FORMAT ('    LOCTIM OUT AT',F15.8)                                LOC  530
      END                                                               LOC  540

      SUBROUTINE ASMTIM (M,T,XP,YP)                                     ASM   10
C                                                                       ASM   20
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SMASM   30
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEEASM   40
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASOASM   50
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,QASM   60
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),ASM   70
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4ASM   80
     60),AMF,HISX(100),JACK(40,7),HISA(100)                             ASM   90
C                                                                       ASM  100
```

```
      IQ = X(55)                                                        ASM  140
      IF (IQ.EQ.0) GO TO 20                                             ASM  150
      CALL GETIMX (ID)                                                  ASM  160
      VEL = ID*0.000026                                                 ASM  170
      WRITE (6,60) VEL                                                  ASM  180
   20 MA = M-90                                                         ASM  190
      ID = IFIX(ASMT(MA,6)+AMF)                                         ASM  200
      VEL = X(2001+(ID-1)*10)                                           ASM  210
      DL = (T-ASMT(MA,5))*VEL                                           ASM  220
      ID = IFIX(ASMT(MA,4)+AMF)                                         ASM  230
      DELTAX = ASMT(MA,7)-SHIP(ID,2)                                    ASM  240
      IF (ABS(DELTAX).LT.5.0E-5) DELTAX=0.0                             ASM  250
      DELTAY = ASMT(MA,8)-SHIP(ID,3)                                    ASM  260
      IF (ABS(DELTAY).LT.5.0E-5) DELTAY=0.0                             ASM  270
      D = DELTAX**2+DELTAY**2                                           ASM  280
      IF (D.EQ.0.) GO TO 50                                             ASM  290
      D = SQRT(D)                                                       ASM  300
      DT = DL/D                                                         ASM  310
      IF (ABS(DT).LT.1.0E-4) DT=0.0                                     ASM  320
      XP = ASMT(MA,7)-DELTAX*DT                                         ASM  330
      YP = ASMT(MA,8)-DELTAY*DT                                         ASM  340
   30 IF (IQ.EQ.0) GO TO 40                                             ASM  350
      CALL GETIMX (ID)                                                  ASM  360
      VEL = ID*0.000026                                                 ASM  370
      WRITE (6,70) VEL                                                  ASM  380
   40 RETURN                                                            ASM  390
   50 XP = ASMT(MA,7)                                                   ASM  400
      YP = ASMT(MA,8)                                                   ASM  410
      GO TO 30                                                          ASM  420
C                                                                       ASM  430
   60 FORMAT (' ASMTIM IN AT',F15.8)                                    ASM  440
   70 FORMAT (' ASMTIM OUT AT',F15.8)                                   ASM  450
      END                                                               ASM  460


C                                                                       HSTG0020
C     SUBROUTINE  HISTG/HISTF          (J5)                             HSTG0030
C                                                                       HSTG0040
C     PURPOSE                                                           HSTG0050
C                                                                       HSTG0060
C         SUBROUTINE HISTG IS INTENDED TO PRODUCE A ONE-PAGE SUMMARY    HSTG0070
C     OF A SET OF DATA BY COMPUTING A SET OF BASIC STATISTICS AND       HSTG0080
C     PRINTING A HISTOGRAM.  IN ADDITION, THE CAPABILITY OF DISPLAYING  HSTG0090
C     A SMOOTHED EMPIRICAL DENSITY FUNCTION PLOT IS PROVIDED.           HSTG0100
C                                                                       HSTG0110
```

```
C     CALLING SEQUENCES                                                 HSTG0120
C                                                                       HSTG0130
C        CALL HISTG(X, N, NBAR)                                         HSTG0140
C                                                                       HSTG0150
C        CALL HISTF(X, N, NBAR)                                         HSTG0160
C                                                                       HSTG0170
C        CALL NOSTAT                                                    HSTG0180
C                                                                       HSTG0190
C        CALL FIX(SCALE)                                                HSTG0200
C                                                                       HSTG0210
C        CALL NOFIX                                                     HSTG0220
C                                                                       HSTG0230
C     ARGUMENTS                                                         HSTG0240
C                                                                       HSTG0250
C        X       A SINGLE DIMENSIONAL ARRAY OF DATA (REAL*4) TO BE      HSTG0260
C                ANALYZED. SORTED IN ASCENDING ORDER ON OUTPUT FROM     HSTG0270
C                HISTF/HISTG.                                           HSTG0280
C                                                                       HSTG0290
C        N       THE NUMBER OF DATA POINTS TO BE CONSIDERED. MUST BE    HSTG0300
C                GREATER THAN 9.                                        HSTG0310
C                                                                       HSTG0320
C        NBAR    THE NUMBER OF BARS IN THE HISTOGRAM.  MUST BE BETWEEN  HSTG0330
C                15 AND 32.  IF NBAR IS SUPPLIED AS ZERO, THE NUMBER OF HSTG0340
C                BARS IN THE HISTOGRAM WILL BE AUTOMATICALLY DETERMINED HSTG0350
C                BASED ON THE NUMBER OF DATA POINTS.                    HSTG0360
C                                                                       HSTG0370
C        SCALE   A VECTOR (REAL*4) OF TWO VALUES USED TO OPTIONALLY FIX HSTG0380
C                THE SCALE FOR THE HISTOGRAM.  SCALE(1) IS THE LOWER    HSTG0390
C                VALUE AND SCALE(2) THE UPPER.                          HSTG0400
C                                                                       HSTG0410
C     USAGE                                                             HSTG0420
C                                                                       HSTG0430
C         THE CALLING SEQUENCE USING THE ENTRY POINT HISTG WILL PRODUCE HSTG0440
C     A SINGLE PAGE OF OUTPUT WITH THE HISTOGRAM AND THE COMPUTED       HSTG0450
C     STATISTICS (BUT SEE ERROR CONDITIONS BELOW).  USING THE ALTERNATE HSTG0460
C     ENTRY POINT HISTF WILL PRODUCE TWO PAGES OF OUTPUT:  THE FIRST    HSTG0470
C     WILL BE IDENTICAL TO THE PAGE FOR HISTG WHILE THE SECOND WILL     HSTG0480
C     SHOW THE EMPIRICAL DENSITY FUNCTION PLOTTED OVER THE BASIC        HSTG0490
C     HISTOGRAM.  THE CALCULATION AND PRINT OUT OF STATISTICS MAY       HSTG0500
C     BE SUPPRESSED BY CALLING NOSTAT.                                  HSTG0510
C                                                                       HSTG0520
C         HISTG/HISTF CALLS ON SUBROUTINE PXSORT TO PERFORM AN IN-PLACE HSTG0530
C     SORT OF THE INPUT DATA SO THAT IT WILL BE IN INCREASING ORDER     HSTG0540
C     UPON RETURN FROM THE SUBROUTINE.  THE VALUES OF THE DATA POINTS   HSTG0550
C     ARE UNCHANGED.                                                    HSTG0560
C                                                                       HSTG0570
C         THE HISTOGRAM SCALE MAY BE FIXED BY CALLING THE ALTERNATE     HSTG0580
C     ENTRY POINT FIX; THE SCALE REMAINS SET AT THESE LIMITS UNLESS     HSTG0590
```

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C     IT IS RESET BY ANOTHER CALL TO FIX OR ALLOWED TO FLOAT (THE           HSTG0600
C     DEFAULT) BY CALLING NOFIX.  WHEN THE SCALE IS FIXED, POINTS           HSTG0610
C     FALLING OUTSIDE THE INTERVAL ARE DISPLAYED IN THE END BARS            HSTG0620
C     OF THE HISTOGRAM.                                                     HSTG0630
C                                                                           HSTG0640
C         THE FOLLOWING BASIC STATISTICS ARE ALSO COMPUTED AND PRINTED      HSTG0650
C     OUT, IF NOSTAT IS NOT CALLED:                                         HSTG0660
C        MEAN, MEDIAN, TRIMEAN, MIDMEAN                                     HSTG0670
C        GEOMETRIC AND HARMONIC MEANS (POSITIVE SAMPLES ONLY)               HSTG0680
C        VARIANCE, STANDARD DEVIATION, COEFFICIENT OF VARIATION, RANGE      HSTG0690
C           AND MIDSPREAD                                                   HSTG0700
C        THIRD AND FOURTH CENTRAL MOMENTS, COEFFICIENTS OF SKEWNESS AND     HSTG0710
C           KURTOSIS                                                        HSTG0720
C        MAXIMUM, MINIMUM AND 5 QUANTILES                                   HSTG0730
C     IN ADDITION, THE MEAN IS DISPLAYED ON THE HISTOGRAM BY A VERTICAL     HSTG0740
C     COLUMN OF "M"'S AND THE QUARTILES BY COLUMNS OF DOTS.                 HSTG0750
C                                                                           HSTG0760
C     INTERPRETING THE OUTPUT                                               HSTG0770
C                                                                           HSTG0780
C         THE DEFINITIONS OF THE BASIC STATISTICS COMPUTED BY               HSTG0790
C     HISTG/HISTF ARE LISTED BELOW.  PAGE NUMBER REFERENCES ARE             HSTG0800
C     TO THE CRC STANDARD MATH TABLES, 19TH EDITION (1971).                 HSTG0810
C                                                                           HSTG0820
C     MEAN       AVERAGE OF THE SAMPLE (P 554).                             HSTG0830
C                                                                           HSTG0840
C     MEDIAN     MID-VALUE OF THE SAMPLE, IF THERE ARE AN ODD NUMBER        HSTG0850
C                OF SAMPLE POINTS, OR THE AVERAGE OF THE TWO MIDDLE         HSTG0860
C                VALUES FOR AN EVEN NUMBER OF POINTS (P 555).               HSTG0870
C                                                                           HSTG0880
C     TRIMEAN    0.25 * (Q  + 2Q  + Q ), WHERE THE Q  ARE THE QUARTILES.    HSTG0890
C                         1     2    3            I                         HSTG0900
C                                                                           HSTG0910
C     MIDMEAN    THE AVERAGE OF ALL SAMPLE VALUES LYING BETWEEN THE         HSTG0920
C                UPPER AND LOWER QUARTILES.                                 HSTG0930
C                                                                           HSTG0940
C     MIDRANGE   AVERAGE OF THE MAXIMUM AND MINIMUM.                        HSTG0950
C                                                                           HSTG0960
C     GEOMETRIC  (P 554).                                                   HSTG0970
C       MEAN                                                                HSTG0980
C                                                                           HSTG0990
C     HARMONIC   (P 555).                                                   HSTG1000
C       MEAN                                                                HSTG1010
C                                                                           HSTG1020
C     VARIANCE   (P 557). UNBIASED ESTIMATORS FOR VARIANCE AND              HSTG1030
C                STANDARD DEVIATION ARE USED.                               HSTG1040
C                                                                           HSTG1050
C     STANDARD   (P 557).                                                   HSTG1060
C     DEVIATION                                                             HSTG1070
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C                                                                       HSTG1080
C     COEFFICIENT OF VARIATION = STANDARD DEVIATION / |MEAN|            HSTG1090
C               WHEN THE MEAN IS LESS THAN 10. ** -30, THE COEFFICIENT  HSTG1100
C               OF VARIATION IS SET TO ZERO.                            HSTG1110
C                                                                       HSTG1120
C     MEAN      (P 556). THE AVERAGE OF THE SUM OF THE ABSOLUTE         HSTG1130
C     DEVIATION DIFFERENCES BETWEEN THE SAMPLE VALUES AND THE           HSTG1140
C               MEDIAN                                                  HSTG1150
C                                                                       HSTG1160
C     RANGE     MAXIMUM - MINIMUM (P 557).                              HSTG1170
C                                                                       HSTG1180
C     MIDSPREAD Q  - Q  , ALSO CALLED INTERQUARTILE DISTANCE.           HSTG1190
C                3    1                                                 HSTG1200
C                                                                       HSTG1210
C     M3        THIRD CENTRAL MOMENT.  UNBIASED ESTIMATOR IS USED.      HSTG1220
C                                                                       HSTG1230
C     M4        FOURTH CENTRAL MOMENT.  UNBIASED ESTIMATOR IS USED.     HSTG1240
C                                                                       HSTG1250
C     COEFFICIENT OF SKEWNESS  M3 / (STD DEV) ** 3                      HSTG1260
C                                                                       HSTG1270
C     COEFFICIENT OF KURTOSIS  (M4 / (STD DEV) ** 4) - 3                HSTG1280
C                                                                       HSTG1290
C     BETA1     BIASED ESTIMATE OF THIRD CENTRAL MOMENT. CAN BE USED    HSTG1300
C               IN TESTING FOR NORMALITY.                               HSTG1310
C                                                                       HSTG1320
C     BETA2     BIASED ESTIMATE OF FOURTH CENTRAL MOMENT.               HSTG1330
C                                                                       HSTG1340
C     MAXIMUM   LARGEST SAMPLE VALUE.                                   HSTG1350
C                                                                       HSTG1360
C     MINIMUM   SMALLEST SAMPLE VALUE.                                  HSTG1370
C                                                                       HSTG1380
C     QUANTILES THE ALPHA-QUANTILE, X(ALPHA), IS THE SOLUTION TO        HSTG1390
C               THE EQUATION                                            HSTG1400
C                  PROBABILITY (X .LE. X(ALPHA) ) = ALPHA.              HSTG1410
C                                                                       HSTG1420
C                                                                       HSTG1430
C         THE EMPIRICAL DENSITY FUNCTION IS PLOTTED WHEN THE ENTRY POINTHSTG1440
C     HISTF IS USED.  THE EMPIRICAL DENSITY FUNCTION GIVES ESSENTIALLY  HSTG1450
C     A "MORE EXACT" PICTURE OF THE DATA THAN DOES THE HISTOGRAM        HSTG1460
C     ALONE.  IT IS DEFINED BY THE RELATION                             HSTG1470
C                                                                       HSTG1480
C                          1      N                                     HSTG1490
C           F (Z)  =  --------  SUM  W( (X  - Z) / B(N) ),              HSTG1500
C            N         N*B(N)   I=1        I                            HSTG1510
C                                                                       HSTG1520
C     WHERE N IS THE NUMBER OF DATA POINTS, B(N) IS A BANDWIDTH         HSTG1530
C     FUNCTION,                                                         HSTG1540
C                                                                       HSTG1550
```

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C              B(N) = RANGE / SQRT(N),                                  HSTG1560
C                                                                       HSTG1570
C     AND W IS A WEIGHT FUNCTION,                                       HSTG1580
C                                                                       HSTG1590
C              W(Z) = 0       IF |Z| > 1                                HSTG1600
C                  = 1 - |Z|  OTHERWISE.                                HSTG1610
C                                                                       HSTG1620
C     F̄ (Z) IS COMPUTED FOR VALUES OF Z BETWEEN THE MAXIMUM AND THE     HSTG1630
C      N                                                                HSTG1640
C     MINIMUM OF THE SAMPLE AND PLOTTED ON TOP OF THE HISTOGRAM         HSTG1650
C     USING THE SYMBOL "F".  THE RELATIVE FREQUENCY MARKS ON THE        HSTG1660
C     LEFT OF THE OUTPUT REFER TO THE HISTOGRAM AND NOT TO THE          HSTG1670
C     DENSITY FUNCTION.                                                 HSTG1680
C                                                                       HSTG1690
C     SUBROUTINES REQUIRED                                              HSTG1700
C                                                                       HSTG1710
C         SUBROUTINE PXSORT IS USED TO ORDER THE SAMPLE.  PXSORT HAS    HSTG1720
C         BEEN COMPILED AND ADDED TO MPSLIB UNDER OS.                   HSTG1730
C                                                                       HSTG1740
C     TIMING AND CORE REQUIREMENTS                                      HSTG1750
C                                                                       HSTG1760
C         HISTG/HISTF REQUIRE 15,984 DECIMAL BYTES OF CORE.  WITH ALL   HSTG1770
C     THE IBM BUILT-IN FUNCTIONS (IBCOM, SQRT, ALOG, ETC.) AND          HSTG1780
C     SUBROUTINE PXSORT, THE TOTAL REQUIREMENT IS ABOUT 38,500 BYTES.   HSTG1790
C                                                                       HSTG1800
C         THE FOLLOWING APPROXIMATE TIME REQUIREMENTS FOR AN IBM/360-67 HSTG1810
C     WERE OBSERVED:                                                    HSTG1820
C                                                                       HSTG1830
C         SAMPLE SIZE (N)        HISTG        HISTF                     HSTG1840
C                                                                       HSTG1850
C             1000               2.17 SEC     3.97 SEC                  HSTG1860
C              500               1.73 SEC     3.40 SEC                  HSTG1870
C              200               1.49 SEC     3.04 SEC                  HSTG1880
C              100               1.42 SEC     2.91 SEC                  HSTG1890
C                                                                       HSTG1900
C                                                                       HSTG1910
C     ERROR CONDITIONS                                                  HSTG1920
C                                                                       HSTG1930
C     SAMPLE SIZE MUST BE AT LEAST 10; IF NOT, AN ERROR MESSAGE IS      HSTG1940
C          PRINTED AND NO OUTPUT IS PRODUCED.                           HSTG1950
C                                                                       HSTG1960
C     THERE MUST BE SOME DIFFERENCES IN THE DATA; IF ALL VALUES OF      HSTG1970
C          X ARE THE SAME, AN ERROR MESSAGE IS PRINTED.                 HSTG1980
C                                                                       HSTG1990
C     PROGRAMMER : D.W. ROBINSON                                        HSTG2000
C                                                                       HSTG2010
C                  ADAPTED FROM A PREVIOUS VERSION CALLED 'HIST'        HSTG2020
C                  PROVIDED BY IBM AND MODIFIED AT NPS BY               HSTG2030
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C                   S.D. RANEY 11/72.                                   HSTG2040
C                                                                       HSTG2050
C     DATE :        DEC 73                                              HSTG2060
C     REVISION 1:   APR 74    ADDED ADDITIONAL STATISTICS AND CALLED    HSTG2070
C                             NEW SORT ROUTINE. PUT IN NOSTAT, FIX AND  HSTG2080
C                             NOFIX SECTIONS.                           HSTG2090
C                                                                       HSTG2100
C                                                                       HSTG2110
C-----------------------------------------------------------------------HSTG2120
C                                                                       HSTG2130
C                                                                       HSTG2140
      SUBROUTINE  HISTG  (X, N, NBAR)                                   HSTG2150
      INTEGER    F, ARRAY, BLK, BMARK, PROB, RVERT                      HSTG2160
      REAL       MIDMN, MIDSPD, MNDEV, MDRNG                            HSTG2170
      LOGICAL*1  PLOT, EM, DOT, VERT, CROSS, BLANK, NUM, FMT, FUNC, EFF HSTG2180
      LOGICAL*1  STAT, FX                                               HSTG2190
      REAL*8   SUM, SUM2, SUM3, SUM4, SUMH                              HSTG2200
      DIMENSION  X(N), XLABEL(33), F(32), PROB(50), NUM(4), FMT(24)     HSTG2210
      DIMENSION  ARRAY(1600), PLOT(128,50), FN(127), SCALE(2)           HSTG2220
      EQUIVALENCE  (PLOT(1,1), ARRAY(1))                                HSTG2230
C                                                                       HSTG2240
      DATA BLK/'    '/, MARK/'*** '/, BMARK/'***+'/, NOMARK/'---+'/     HSTG2250
      DATA RVERT/'   |'/, FUNC/.TRUE./, STAT/.TRUE./, FX/.FALSE./       HSTG2260
      DATA NOUT/6/                                                      HSTG2270
      DATA  EFF/'F'/,EM/'M'/,DOT/'.'/,VERT/'|'/,CROSS/'+'/, BLANK/' '/  HSTG2280
C-----THIS STATEMENT WILL PRODUCE A SIZE WARNING:-                      HSTG2290
      DATA  NUM/4H3210/, FMT/24H(1XF6.2,15(3XF5.2),F6.2)/               HSTG2300
C                                                                       HSTG2310
C     SET FLAG SO EMPIRICAL D.F. IS NOT PLOTTED                         HSTG2320
      FUNC = .FALSE.                                                    HSTG2330
C                                                                       HSTG2340
C     ENTRY POINT FOR DENSITY FUNCTION PLOT ROUTINE                     HSTG2350
      ENTRY HISTF (X, N, NBAR)                                          HSTG2360
C                                                                       HSTG2370
C     TEST N                                                            HSTG2380
      AN = N                                                            HSTG2390
      IF(N .GE. 10) GO TO 10                                            HSTG2400
      WRITE(NOUT,5) N                                                   HSTG2410
    5 FORMAT('1***HISTG  SAMPLE SIZE TOO SMALL:',I11)                   HSTG2420
      FUNC = .TRUE.                                                     HSTG2430
      RETURN                                                            HSTG2440
C                                                                       HSTG2450
C     SORT THE SAMPLE                                                   HSTG2460
   10 CALL PXSORT(X, 1, N)                                              HSTG2470
C                                                                       HSTG2480
C     GET FREQUENCY INTERVALS FOR BARS AND COUNT NO VALUES IN EACH      HSTG2490
C-----SEE WHETHER TO USE AUTO NBARS DETERMINATION                       HSTG2500
      NBARS = NBAR                                                      HSTG2510
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      IF ( (NBAR .GE. 15) .AND. (NBAR .LE. 32) ) GO TO 20               HSTG2520
      NBARS = 15                                                        HSTG2530
      IF(N .GE. 80) NBARS = MINO(32, N/5)                               HSTG2540
   20 MAX = NBARS * 4                                                   HSTG2550
      NBP1 = NBARS + 1                                                  HSTG2560
      NBM1 = NBARS - 1                                                  HSTG2570
      LIM E = MINO(NBP1, 32)                                            HSTG2580
      RANGE = X(N) - X(1)                                               HSTG2590
      IF(RANGE .GT. 0.0) GO TO 40                                       HSTG2600
C     RANGE OF SAMPLE IS .LE. 0; PRINT ERROR MESSAGE                    HSTG2610
      WRITE(NOUT,30) X(1)                                               HSTG2620
   30 FORMAT('1***HISTG  SAMPLE IS CONSTANT. SAMPLE VALUES ARE',1PE16.6)HSTG2630
      GO TO 450                                                         HSTG2640
C                                                                       HSTG2650
   40 IF(FX) GO TO 50                                                   HSTG2660
      XMIN = X(1)                                                       HSTG2670
      HSCALE = RANGE                                                    HSTG2680
   50 DELTA = HSCALE / FLOAT(NBARS)                                     HSTG2690
      K = 1                                                             HSTG2700
      XLABEL(1) = XMIN                                                  HSTG2710
      DO 80 J=1,NBARS                                                   HSTG2720
      F(J) = 0                                                          HSTG2730
      TOP = XMIN + J * DELTA                                            HSTG2740
      XLABEL(J+1) = TOP                                                 HSTG2750
      IF(K .GT. N) GO TO 80                                             HSTG2755
      DO 60 I=K,N                                                       HSTG2760
      IF(X(I) .GT. TOP) GO TO 70                                        HSTG2770
      F(J) = F(J) + 1                                                   HSTG2780
   60 CONTINUE                                                          HSTG2790
      I=N + 1                                                           HSTG2800
   70 K = I                                                             HSTG2810
   80 CONTINUE                                                          HSTG2820
      IF ( K .LE. N) F(NBARS) = F(NBARS) + N - K + 1                    HSTG2830
C     SCALE FREQUENCIES                                                 HSTG2840
   90 FMAX = F(1)                                                       HSTG2850
      DO 100 I=2,NBARS                                                  HSTG2860
      FMAX = AMAX1(FMAX, FLOAT(F(I)))                                   HSTG2870
  100 CONTINUE                                                          HSTG2880
C                                                                       HSTG2890
C     BLANK PRINT ARRAY                                                 HSTG2900
      DO 110 I=1,1600                                                   HSTG2910
      ARRAY(I) = BLK                                                    HSTG2920
  110 CONTINUE                                                          HSTG2930
C                                                                       HSTG2940
C     PLOT THE BARS                                                     HSTG2950
      LIM = 1536                                                        HSTG2960
      FSCALE = 49. / FMAX                                               HSTG2970
      DO 140 I=1,NBARS                                                  HSTG2980
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      LIM = LIM + 1                                                     HSTG2990
      ARRAY(LIM+32) = BMARK                                             HSTG3000
      LINE = 50.5 - FSCALE * F(I)                                       HSTG3010
      IF (LINE .GE. 50) GO TO 130                                       HSTG3020
      LINE = LINE * 32 + I - 32                                         HSTG3030
      DO 120 J = LINE, LIM, 32                                          HSTG3040
      ARRAY(J) = MARK                                                   HSTG3050
  120 CONTINUE                                                          HSTG3060
      GO TO 140                                                         HSTG3070
  130 IF(F(I) .EQ. 0) ARRAY(LIM+32) = NOMARK                            HSTG3080
  140 CONTINUE                                                          HSTG3090
C                                                                       HSTG3100
C     FIND PROBABILITY MARKERS                                          HSTG3110
      PROBMX = FMAX / AN                                                HSTG3120
      DO 150 I=1,50                                                     HSTG3130
      PROB(I) = 0                                                       HSTG3140
  150 CONTINUE                                                          HSTG3150
      INCR = 5                                                          HSTG3160
      IF(PROBMX .LT. .20) INCR = 2                                      HSTG3170
      IF(PROBMX .LT. .10) INCR = 1                                      HSTG3180
      J = INCR                                                          HSTG3190
  160 Q = J / 100.0                                                     HSTG3200
      IF ( Q .GE. PROBMX) GO TO 170                                     HSTG3210
      LINE = (1. - Q / PROBMX) * 49. + 1.5                              HSTG3220
      PROB(LINE) = J                                                    HSTG3230
      J = J + INCR                                                      HSTG3240
      GO TO 160                                                         HSTG3250
C                                                                       HSTG3260
C     FIND THE MEAN                                                     HSTG3270
  170 SUM = 0.D0                                                        HSTG3280
      DO 175 I=1,N                                                      HSTG3290
      SUM = SUM + X(I)                                                  HSTG3300
  175 CONTINUE                                                          HSTG3310
      XMEAN = SUM/AN                                                    HSTG3320
C                                                                       HSTG3330
C     FIND THE QUANTILE ESTIMATES                                       HSTG3340
      IQ1 = N / 4                                                       HSTG3350
      IQ2 = N / 2                                                       HSTG3360
      IQ3 = N - IQ1                                                     HSTG3370
      M2M = 1 - MOD(N,2)                                                HSTG3380
      M1 = 1 - MOD(N,4)/2                                               HSTG3390
      M12 = 1 + M1                                                      HSTG3400
      XQ1 = (M1 * X(IQ1) + X(IQ1 + 1)) / M12                            HSTG3410
      XQ2 = (M2M * X(IQ2) + X(IQ2+1)) / (1 + M2M)                       HSTG3420
      XQ3 = (M1 * X(IQ3+1) + X(IQ3)) / M12                              HSTG3430
      XQ10 = X(N/10)                                                    HSTG3440
      XQ90 = X(9*N/10)                                                  HSTG3450
C                                                                       HSTG3460
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C     PLOT THE MEAN AND THE QUANTILES                                   HSTG3470
      R = (MAX-2.0) / HSCALE                                            HSTG3480
      IQ1 = (XQ1 - XMIN) * R + 1.5                                      HSTG3490
      IQ2 = (XQ2 - XMIN) * R + 1.5                                      HSTG3500
      IQ3 = (XQ3 - XMIN) * R + 1.5                                      HSTG3510
      MEAN = (XMEAN - XMIN) * R + 1.5                                   HSTG3520
C-----INSURE MEAN AND QUARTILES PLOT ON GRAPH                           HSTG3530
      IF(MEAN .LT. 1) MEAN = 1                                          HSTG3540
      IF(MEAN .GT. MAX) MEAN = MAX                                      HSTG3550
      IF(IQ1 .LT. 1) IQ1 = 1                                            HSTG3560
      IF(IQ2 .LT. 1) IQ2 = 1                                            HSTG3570
      IF(IQ3 .LT. 1) IQ3 = 1                                            HSTG3580
      IF(IQ1 .GT. MAX) IQ1 = MAX                                        HSTG3590
      IF(IQ2 .GT. MAX) IQ2 = MAX                                        HSTG3600
      IF(IQ3 .GT. MAX) IQ3 = MAX                                        HSTG3610
  179 DO 180 I=1,50                                                     HSTG3620
      PLOT(IQ1,I) = DOT                                                 HSTG3630
      PLOT(IQ2,I) = DOT                                                 HSTG3640
      PLOT(IQ3,I) = DOT                                                 HSTG3650
      PLOT(MEAN,I) = EM                                                 HSTG3660
      PLOT(MAX,I) = VERT                                                HSTG3670
  180 CONTINUE                                                          HSTG3680
C-----BYPASS STATISTIC COMPUTATION, IF DESIRED                          HSTG3690
      IF(.NOT. STAT) GO TO 198                                          HSTG3700
C                                                                       HSTG3710
C     COMPUTE MEAN AND MOMENT ESTIMATES                                 HSTG3720
      MDRNG = 0.5 * (X(1) + X(N))                                       HSTG3730
      SUM  = 0.0D0                                                      HSTG3740
      SUM2 = 0.0D0                                                      HSTG3750
      SUM3 = 0.0D0                                                      HSTG3760
      SUM4 = 0.0D0                                                      HSTG3770
      DO 190 I=1,N                                                      HSTG3780
      SUM = SUM + ABS(X(I) - XQ2)                                       HSTG3790
      DEV = X(I) - XMEAN                                                HSTG3800
      SUM2 = SUM2 + DEV * DEV                                           HSTG3810
      SUM3 = SUM3 + DEV ** 3                                            HSTG3820
      SUM4 = SUM4 + DEV ** 4                                            HSTG3830
  190 CONTINUE                                                          HSTG3840
      VAR = SUM2 / (AN - 1.0)                                           HSTG3850
      STDV = SQRT(VAR)                                                  HSTG3860
      MNDEV = SUM / AN                                                  HSTG3870
      XSUM3 = SNGL(SUM3) * AN /( (AN-1.) * (AN-2.))                     HSTG3880
      SKEW = XSUM3  / STDV ** 3                                         HSTG3890
      BETA1 = SUM3 / AN                                                 HSTG3900
      XSUM4 = SUM4 * ((AN-2.) * AN + 3.) / ((AN-1.) * (AN-2.) * (AN-3.))HSTG3910
      XSUM4 = XSUM4 - VAR*VAR*3.*(AN-1.)*(AN+AN-3.)/(AN*(AN-2.)*(AN-3)) HSTG3920
      CKURT = XSUM4 / (VAR * VAR) - 3.                                  HSTG3930
      BETA2 = SUM4 / AN                                                 HSTG3940
```

```
      CVAR = 0.0                                                        HSTG3950
      IF (ABS(XMEAN) .GT. 1.E-30) CVAR = STDV / ABS(XMEAN)              HSTG3960
C                                                                       HSTG3970
      MIDSPD = XQ3 - XQ1                                                HSTG3980
      TRIMN = 0.25 * (XQ1 + XQ2 + XQ2 + XQ3)                            HSTG3990
      SUM = XQ1 + XQ3                                                   HSTG4000
      IQ1 = N/4 + 2                                                     HSTG4010
      IQ3 = N - IQ1 + 1                                                 HSTG4020
      DO 92 I=IQ1,IQ3                                                   HSTG4030
      SUM = SUM + X(I)                                                  HSTG4040
   92 CONTINUE                                                          HSTG4050
      MIDMN = SUM/(IQ3 - IQ1 + 3)                                       HSTG4060
C                                                                       HSTG4070
C     GET GEOMETRIC AND HARMONIC MEANS FOR POSITIVE RANDOM VARIABLES    HSTG4080
      IF(X(1) .LE. 0.0) GO TO 198                                       HSTG4090
      SUM = 0.0D0                                                       HSTG4100
      SUMH = 0.0D0                                                      HSTG4110
      DO 195 I=1,N                                                      HSTG4120
      SUM = SUM + ALOG(X(I))                                            HSTG4130
      SUMH = SUMH + 1./X(I)                                             HSTG4140
  195 CONTINUE                                                          HSTG4150
      GEOM = SUM / AN                                                   HSTG4160
      GEOM = EXP(GEOM)                                                  HSTG4170
      HARM = AN / SUMH                                                  HSTG4180
C                                                                       HSTG4190
C     WRITE THE FREQUENCIES                                             HSTG4200
  198 WRITE(NOUT,200) N, (F(I), I=1,NBARS)                              HSTG4210
  200 FORMAT('1',5X,'FREQUENCIES',36X,'SAMPLE SIZE =',I5//4X32I4)       HSTG4220
C                                                                       HSTG4230
C     DRAW THE TOP OF THE GRAPH                                         HSTG4240
      WRITE(NOUT,210) BLK, CROSS, (NOMARK,I=1,NBARS)                    HSTG4250
      WRITE(NOUT,210) BLK, VERT, (BLK,I=1,NBM1), RVERT                  HSTG4260
  210 FORMAT(A4,A1,32A4)                                                HSTG4270
C                                                                       HSTG4280
C     PLOT THE GRAPH PART                                               HSTG4290
      DO 240 I=1,50                                                     HSTG4300
      IF(PROB(I) .EQ. 0) WRITE(NOUT,220) (PLOT(J,I), J=1,MAX)           HSTG4310
  220 FORMAT(4X,'|',128A1)                                              HSTG4320
      IF( (PROB(I) .GT. 0) .AND.                                        HSTG4330
     *   (PROB(I) .LT. 10)) WRITE(NOUT,225) PROB(I),(PLOT(J,I),J=1,MAX)HSTG4340
  225 FORMAT(' .0',I1,'|',128A1)                                        HSTG4350
      IF(PROB(I) .GT. 9) WRITE(NOUT,230) PROB(I), (PLOT(J,I),J=1,MAX)   HSTG4360
  230 FORMAT(1X,'.',I2,'|',128A1)                                       HSTG4370
  240 CONTINUE                                                          HSTG4380
C                                                                       HSTG4390
C     WRITE OUT THE SCALE ALONG THE BOTTOM                              HSTG4400
      WRITE(NOUT,250) (RVERT, I=1,NBP1,2)                               HSTG4410
  250 FORMAT(1X,16(A4,4X),A4)                                           HSTG4420
```

```
      XS = AMAX1 (ABS(X(1)), ABS(X(N)) )                                HSTG4430
      IF ( (XS .LT. .001) .OR. (XS .GE. 1000.) ) GO TO 260              HSTG4440
      J = ALOG10(XS) + 2.0                                              HSTG4450
      IF(J .LE. 0) J = 1                                                HSTG4460
      FMT(7) = NUM(J)                                                   HSTG4470
      FMT(17) = NUM(J)                                                  HSTG4480
      FMT(23) = NUM(J)                                                  HSTG4490
      WRITE(NOUT,FMT) (XLABEL(I), I=1,NBP1, 2)                          HSTG4500
      GO TO 290                                                         HSTG4510
  260 WRITE(NOUT,270) (XLABEL(I), I=1, LIM E, 4)                        HSTG4520
  270 FORMAT(1X1PE9.2,2X,'|',7(3XE9.2,3X,'|'),7X,'|')                   HSTG4530
      WRITE(NOUT,280) (XLABEL(I), I=3, LIM E, 4)                        HSTG4540
  280 FORMAT(8X1PE9.2, 7(7X, E9.2))                                     HSTG4550
C                                                                       HSTG4560
  290 IF (FX) WRITE(NOUT,295) XMIN, XMAX                                HSTG4570
  295 FORMAT(//'     SCALE FIXED FROM',1PE14.6,' TO',E14.6)             HSTG4580
C                                                                       HSTG4590
C     BYPASS STATISTICS, IF REQUESTED                                   HSTG4600
      IF(.NOT. STAT) GO TO 330                                          HSTG4610
C     WRITE OUT THE STATISTICS                                          HSTG4620
      WRITE(NOUT,300) XMEAN, VAR, XSUM3, X(1), XQ2, STDV, XSUM4, XQ10,  HSTG4630
     *             TRIMN, CVAR, SKEW, XQ1, MIDMN, MNDEV, CKURT, XQ2,    HSTG4640
     *             MDRNG, RANGE, BETA1, XQ3                             HSTG4650
  300 FORMAT(///'OCENTRAL TENDENCY',11X, 'SPREAD',21X, 'HIGHER CENTRAL MHSTG4660
     *OMENTS', 4X, 'DISTRIBUTION'/                                      HSTG4670
     *       'OMEAN',5X1PE14.6,4X,'VARIANCE ',E14.6,4X,'M3',6X,E14.6,4X,HSTG4680
     *          'MINIMUM',14X,E14.6/                                    HSTG4690
     *       ' MEDIAN   ',E14.6,4X,'STD DEV  ',E14.6,4X,'M4',6XE14.6,   HSTG4700
     *          4X, '.10 QUANTILE',9X,E14.6/                            HSTG4710
     *       ' TRIMEAN  ',E14.6,4X,'COEF VAR ',E14.6,4X,'SKEWNESS',E14.6HSTG4720
     *          ,4X, '.25 QUANTILE (HINGE) ',E14.6/                     HSTG4730
     *       ' MIDMEAN  ',E14.6,4X,'MEAN DEV ',E14.6,4X,'KURTOSIS',     HSTG4740
     *          E14.6,4X,'.50 QUANTILE (MEDIAN)',E14.6/                 HSTG4750
     *       ' MIDRANGE ',E14.6,4X,'RANGE    ',E14.6,4X,'BETA1   ',     HSTG4760
     *          E14.6,4X,'.75 QUANTILE (HINGE) ',E14.6)                 HSTG4770
C                                                                       HSTG4780
      IF(X(1) .GT. 0.0) WRITE(NOUT,310)GEOM, MIDSPD, BETA2, XQ90,       HSTG4790
     *                                  HARM, X(N)                      HSTG4800
  310 FORMAT(' GEOM MEAN',1PE14.6,4X,'MIDSPREAD',E14.6,4X,'BETA2   ',   HSTG4810
     *       E14.6,4X,'.90 QUANTILE',9X,E14.6/                          HSTG4820
     *       ' HARM MEAN',E14.6,57X,'MAXIMUM',14X,E14.6//)              HSTG4830
C                                                                       HSTG4840
      IF(X(1) .LE. 0.0) WRITE(NOUT,320)MIDSPD, BETA2, XQ90, X(N)        HSTG4850
  320 FORMAT(28X,'MIDSPREAD',1PE14.6,4X,'BETA2   ',E14.6,4X,            HSTG4860
     *          '.90 QUANTILE',9X,E14.6/                                HSTG4870
     *       81X,'MAXIMUM',14X,E14.6//)                                 HSTG4880
C                                                                       HSTG4890
  330 CONTINUE                                                          HSTG4900
```

```
      IF(.NOT. FUNC) GO TO 450                                          HSTG4910
      FUNC = .FALSE.                                                    HSTG4920
C                                                                       HSTG4930
C     FIND AND PLOT FN (EMPIRICAL DENSITY FUNCTION)                     HSTG4940
C-----BANDWIDTH                                                         HSTG4950
      BN = SQRT(AN) / RANGE                                             HSTG4960
      XN = BN / AN                                                      HSTG4970
C-----EMPIRICAL DENSITY FUNCTION CALCULATION                            HSTG4980
      LOW = 1                                                           HSTG4990
      FMAX = -10.0                                                      HSTG5000
      XINC = HSCALE /MAX                                                HSTG5010
      MAXM1 = MAX - 1                                                   HSTG5020
      DO 430 I=1,MAXM1                                                  HSTG5030
      U = XMIN + I * XINC                                               HSTG5040
      FN(I) = 0.0                                                       HSTG5050
      DO 410 J=LOW,N                                                    HSTG5060
      TRY = (U - X(J) ) * BN                                            HSTG5070
      IF(TRY .GT.  1.0) GO TO 400                                       HSTG5080
      IF(TRY .LT. -1.0) GO TO 420                                       HSTG5090
C-----WEIGHT FUNCTION                                                   HSTG5100
      FN(I) = FN(I) + 1.0 - ABS(TRY)                                    HSTG5110
      GO TO 410                                                         HSTG5120
  400 LOW = J                                                           HSTG5130
  410 CONTINUE                                                          HSTG5140
  420 FN(I) = FN(I) * XN                                                HSTG5150
      FMAX = AMAX1(FMAX, FN(I))                                         HSTG5160
  430 CONTINUE                                                          HSTG5170
C-----PLOT THE DENSITY FUNCTION                                         HSTG5180
      DO 440 I=1,MAXM1                                                  HSTG5190
      LINE = 50.5 - 49.0 * FN(I) / FMAX                                 HSTG5200
      PLOT(I, LINE) = EFF                                               HSTG5210
  440 CONTINUE                                                          HSTG5220
C-----PRINT THE REVISED HISTOGRAM                                       HSTG5230
      GO TO 198                                                         HSTG5240
C                                                                       HSTG5250
C     RESET FUNCTION FLAG AND QUIT                                      HSTG5260
  450 FUNC = .TRUE.                                                     HSTG5270
      RETURN                                                            HSTG5280
C                                                                       HSTG5290
      ENTRY NOSTAT                                                      HSTG5300
C                                                                       HSTG5310
C     ENTRY POINT TO SET STATISTIC FLAG TO SUPPRESS                     HSTG5320
C     CALCULATION AND PRINTOUT OF STATISTICS                            HSTG5330
C                                                                       HSTG5340
      STAT = .FALSE.                                                    HSTG5350
      RETURN                                                            HSTG5360
C                                                                       HSTG5370
      ENTRY FIX(SCALE)                                                  HSTG5380
```

```
C
      FX = .TRUE.
      XMIN = AMIN1(SCALE(1), SCALE(2))
      XMAX = AMAX1(SCALE(1), SCALE(2))
      HSCALE = XMAX - XMIN
C-----TEST FOR VALIDITY
      IF (HSCALE .LE. 0.0) FX = .FALSE.
      RETURN
C
      ENTRY NOFIX
      FX = .FALSE.
      RETURN
C
      END


      SUBROUTINE DISPL
C
C         SUBROUTINE DISPL PROVIDES A GEORGRAPHICAL DISPLAY OF THE
C         BLUE SURFACE UNITS.  THE MAXIMUM RANGE SCALE IS 200 NM FROM
C         FORCE CENTER.  A 100 NM CIRCLE IS DRAWN ON THE PLOT.
C
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SM
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEE
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASO
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,Q
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4
     60),AMF,HISX(100),JACK(40,7),HISA(100)
      DIMENSION XSHIP(40),YSHIP(40),CSHIP(40),XXSHIP(40)
      DIMENSION CX(1257),CY(1257)
      DO 1 I = 1,NS
      XSHIP(I) = 4.0 + 0.0200*SHIP(I,2)
      YSHIP(I) = 4.0 + 0.0200*SHIP(I,3)
    1 CONTINUE
      CALL PLOTS
      CALL AXIS(4.0,0.0,' ',1,8.0,90.0,-200.0,50.0)
      CALL AXIS(0.0,4.0,' ',1,8.0,00.0,-200.0,50.0)
      CALL LINE(XSHIP,YSHIP,NS,1,-4)
      DO 2 I = 1,NS
      XXSHIP(I) = XSHIP(I) + 0.1
      CSHIP(I) = I
      CALL NUMBER(XXSHIP(I),YSHIP(I),0.14,CSHIP(I),0.0,-1)
    2 CONTINUE
      DO 33 N = 1,1257
      T = FLOAT(N)/100.
      CX(N) = 4.0 + 2.00*SIN(T)
      CY(N) = 4.0 + 2.00*COS(T)
```

```
   33 CONTINUE
      CALL LINE(CX,CY,1257,1,7)
      CALL SYMBOL(0.0,8.0,0.14,'SHIP POSITIONS',0.0,14)
      CALL SYMBOL(0.0,8.5,0.14,'FLT AIR DEF SIM',0.0,15)
      CALL SYMBOL(3.7,8.25,0.14,'NORTH',0.0,5)
      CALL PLOT(0.0,12.0,-3)
      CALL PLOTE
      RETURN
      END


      SUBROUTINE RAIDIS
C
C         SUBROUTINE RADIS PROVIDES A GEOGRAPHICAL DISPLAY OF RAIDER
C          TRACKS FROM THEIR INITIAL POSITION (IP) TO LAUNCH POSITION.
C          IN THE CASE WHERE A RAIDER DOES NOT HAVE A LAUNCH POSITION,
C          THE 30 MIN GAME TIME POSITION IS DISPLAYED.  IF THE LAUNCH
C          OR 30 MIN POSITION ARE MORE THAN 800 NM FROM THE CENTER,
C          NO TRACK IS DISPLAYED AT THE LOCATION OF THE RAIDER'S IP.
C          800 NM IS THE MAXIMUM DISTANCE FOR THE PLOT
C
      COMMON X(2744),ASMT(100,8),SAMASM(300,7),RAID(90,17),SHIP(40,6),SM
     1AT(300,10),IVENTS(1000,2),STATS(40,2),IBAT(40,4),NONO(190,40),ISEE
     2D,MAMBAT,KOUNT,NADAR(40,19),RXATA(5),LOVER,ITEMS,PLIST(40,6),REASO
     3N,CHANEL(40,4,3,6),NASM,JAM(4),TMAX,NRTGT(90),MISLFT(90,2),NR,NS,Q
     4RT(50),IFLASK,IGAGE(190),ISAG(40),IFAG,ISBG(40),IFBG,RELOAD(40,4),
     5MARY(100),CHECK,IFIRST,NPGS,KMART(4),NSAM,TGTAV(190),TCF(6),IHIT(4
     60),AMF,HISX(100),JACK(40,7),HISA(100)
      DIMENSION XRAID(2),YRAID(2)
      CALL PLOTS
      CALL AXIS(0.0,4.0,' ',1,8.0,00.0,-800.0,200.0)
      CALL AXIS(4.0,0.0,' ',1,8.0,90.0,-800.0,200.0)
      DO 30 I=1,NR
      LFLAG = 0
      CRAID=I
      XRAID(1) = 4.0 + 0.00500*RAID(I,3)
      YRAID(1) = 4.0 + 0.00500*RAID(I,4)
      IF(ABS(RAID(I,7)).GT.800.0.OR.ABS(RAID(I,8)).GT.800.0) GO TO 40
        XRAID(2) = 4.0 + 0.00500*RAID(I,7)
        YRAID(2) = 4.0 + 0.00500*RAID(I,8)
   20   CONTINUE
      CALL LINE(XRAID,YRAID,2,1,3)
      XXRAID = XRAID(1) + 0.05
      CALL NUMBER(XXRAID,YRAID(1),0.07,CRAID,0.0,-1)
      XXRAID = XXRAID    + 0.15
      CALL SYMBOL(XXRAID,YRAID(1),0.07,'IP',0.0,2)
      XTRAID = XRAID(2) + 0.05
      CALL NUMBER (XTRAID,YRAID(2),0.07,CRAID,0.0,-1)
```

```
      XTRAID = XTRAID + 0.15
      IF (LFLAG.EQ.1) GO TO 70
      CALL SYMBOL(XTRAID,YRAID(2),0.07,'LAUNCH',0.0,6)
   25     CONTINUE
      CALL WHERE(XNOW,YNOW)
      CALL PLOT(XNOW,YNOW,3)
      GO TO 30
   40     LFLAG = 1
      CALL LOCTIM (I,30.,1,XRAID(2),YRAID(2))
      IF (ABS(XRAID(2)).GT.800.0.OR.ABS(YRAID(2)).GT.800.0) GO TO 60
      XRAID(2) = 4.0 + 0.00500*XRAID(2)
      YRAID(2) = 4.0 + 0.00500*YRAID(2)
          GO TO 20
   60     CONTINUE
      CALL SYMBOL (XTRAID,YRAID(1),0.07,CRAID,0.0,-1)
      XTRAID = XRAID(1) + 0.05
      CALL SYMBOL (XTRAID,YRAID(1),0.07,'NO TRACK',0.0,8)
          GO TO 25
   70     CONTINUE
      CALL SYMBOL (XTRAID,YRAID(2),0.07,'30 MIN',0.0,6)
          GO TO 25
   30 CONTINUE
      CALL SYMBOL(0.5,8.0,0.14,'RAIDER TRACKS',0.0,13)
      CALL SYMBOL(0.5,8.5,0.14,'FLT AIR DEF SIM',0.0,15)
      CALL SYMBOL(3.7,8.25,0.14,'NORTH',0.0,5)
      CALL PLOT(0.0,12.0,-3)
      CALL PLOTE
      RETURN
      END

SETIMX   START
         SAVE   (14,12)
         LR     12,15
         USING SETIMX,12
         ST     13,TEMP
         LA     13,SAVE
         STIMER TASK,FIXUP,TUINTVL=TIME
         L      13,TEMP
         RETURN (14,12),T
         DROP   12
FIXUP    SAVE   (14,12)
         RETURN (14,12)
         ENTRY GETIMX
GETIMX   SAVE   (14,12)
         LR     12,15
         USING GETIMX,12
         L     2,0(1)
```

```
         ST    13,TEMP
         LA    13,SAVE
         TTIMER
         L     1,TIME
         SR    1,0
         ST    1,0(2)
         L     13,TEMP
         RETURN (14,12),T
SAVE     DS     18F
TEMP     DS     F
TIME     DC     X'7FFFFFFF'
         END

      FUNCTION RADIAN (RD)                                              RAT   10
C                                                                       RAT   20
C          CONVERTS FROM DEGREES TO RADIANS.                            RAT   30
C                                                                       RAT   40
      IMPLICIT REAL*8(R)                                                RAT   50
      RADIAN = RD*0.017453293                                           RAT   60
      RETURN                                                            RAT   70
      END                                                               RAT   80


//LINK.SYSPRINT DD SYSOUT=0
//LINK.SYSIN DD *
//GO.FT06F001 DD SPACE=(CYL,(4,2)),SYSOUT=0
//GO.SYSIN DD *
C                   JOB COMPLETE
```

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c.1 A computer simulation
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